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NEW YORK, MARCH, 1891.

THE deaths of the Admiral of the Navy and the General of the Army, coming close together, remove at once almost the last of those who held high command during the late war. General Sherman had been actually retired from service for some time, and Admiral Porter's health had prevented him from exercising command for several years, so that neither had taken an active part in the later developments of the two services. Both played great parts when there was need of their services, and both owed their high rank to pre-eminent merit as leaders on land and by sea.

THE complete statistics gathered by the American Iron & Steel Association show that the total production of pig iron in the United States, in 1890, was 10,307,028 net tons of 2,000 tons. This is an increase of 1,790,949 tons or a little over 20 per cent. over 1889, and was the largest output ever reported in the United States in a single year. The production was pretty equally distributed throughout the year, the second half showing only about 90,000 tons more than the first. Of the total production 703,522 tons were made with charcoal as a fuel; 2,448,781 tons with anthracite coal, and the remaining 7,154,725 tons with bituminous coal or coke. This classification is not altogether strict, as in many anthracite furnaces coke is used with the coal. Of the total production 4,583,424 tons are classed as Bessemer pig—that is, iron adapted for the manufacture of steel. This great output entered very largely into consumption, as the stocks reported unsold at the close of the year were less than 700,000 tons.

This production puts the United States at the head of the iron-producing countries, as it has passed Great Britain in the quantity of iron yearly made.

IT is hardly likely that 1891 will show as large a production as 1890. The February report compiled by the *American Manufacturer* shows a considerable falling off in the furnaces in blast. On February 1 there were 274 furnaces running, the weekly capacity of which was 139,340 tons, which is a decrease of 32 furnaces in number and of 24,942 tons in weekly capacity since January 1. The falling off is pretty generally distributed and is not all in one district. The furnaces which have gone out of blast were in both Eastern and Western Pennsylvania, Ohio, Virginia, West Virginia, and Michigan. The Southern furnaces remain about the same, one or two in Alabama and Georgia having stopped for repairs, but their places were taken by others.

NO bids were received at the Navy Department for the fast torpedo cruiser, for which bids were asked some time ago to be sent in February. This result was not unexpected, as the price fixed by law was hardly sufficient to pay for the construction of the vessel required. To attain the speed of 23 knots, which was specified, on so small a displacement as was required in this case, is not a very easy matter, and would make it necessary to build a very expensive vessel with enormous engine power in proportion to tonnage and considerable structural strength to enable her to carry the engines. New proposals may be advertised for, but it is quite probable that no further action will be taken unless Congress modifies the law so as to permit the offer of an increased price or a lowering of the speed conditions.

AN application has been made to Congress to authorize the guarantee by the United States of $100,000,000 bonds of the Nicaraugua Canal Company. The bill has met with considerable favor, but its passage is still in doubt, owing to the great press of business at the short session, and the little time remaining which would enable its opponents to prevent its passage, even if they should prove to be in a minority. The arguments in favor of the proposition are that it will be very difficult to procure the money for the construction of the Canal in this country without some such action, and that it will be very much to the disadvantage of the United States to have the Canal built with foreign capital. Its control is a matter of great importance to this country, and to allow it to pass into the hands of a foreign Government would be extremely unwise. That the Canal itself is entirely practicable is now fully established, and the only question remaining to be considered is that of ways and means. Should the proposal for a guarantee fail in the present Congress, it will undoubtedly be brought forward in the next, and with considerable prospect of success.

IN his recent annual message, the Governor of Missouri makes a strong appeal for better wagon roads. He refers to the condition of the roads generally throughout the State, and speaks of the cost to the farmer of poor roads, and the great advantages of improving their condition. Nothing, he says, would be more beneficial to the State at large than a comprehensive system of good roads. It is hoped that the Legislature will act on this suggestion and will take some steps for the improvement of the highways of the State.

IT is reported that the Grand Trunk Company purposes building a new bridge over the Niagara River near the present suspension bridge. The latter is to be retained for passenger trains only, and the new structure used for freight purposes, the suspension bridge being considered insufficient for the present traffic of the road. Plans for a stone arch bridge have been prepared by Mr. L. L. Buck,

and it is said that his estimates are so low that the stone bridge will probably be constructed.

THE Commission appointed by Congress to select a site for a new dry dock on the Pacific Coast has recommended Point Turner at Port Orchard, in Puget Sound, as the site, thus repeating the recommendation made some time ago by a committee of Naval Officers. The present Commission includes army and navy officers and civilians, and its members have made a careful examination of the coast and bays of Oregon and Washington.

It is to be hoped that Congress will endorse this recommendation by a prompt appropriation, and that provision also will be made for building up a navy yard at the same point. The only yard on the Pacific Coast at present is at Mare Island, and it is certainly necessary to supplement that by another, especially when we consider the growing importance of Puget Sound and the waters to the northward.

THE New York, New Haven & Hartford Company, which has heretofore steadily opposed the introduction of continuous heating on its trains, has at last decided to adopt it, having closed a contract with the Consolidated Car Heating Company, of Albany, to equip at once a large number of cars. The system to be used is the "consolidated disk drum," which is to be used to heat the water in the Baker heater pipes already in the cars. The Sewall coupler will be used for the steam pipes.

In justice to the New Haven Company, it may be said that this change is not the result of public pressure arising from the recent accident in New York, as negotiations for the use of this system had been going on for some weeks before the accident.

DURING its last fiscal year the Baltimore & Ohio Company made a considerable advance both in traffic and earnings, and had upon the whole the most prosperous year for some time past. The improvements made in the road and equipment are very considerable, and more are in prospect. These include the construction of several large storage yards and freight stations at different points and considerable additions to the stock of locomotives and cars. The freight for New York is now handled entirely from the Staten Island terminus.

The Company has made and is making some additions to its mileage. These include the purchase and construction of three short lines in Western Maryland and West Virginia, which will bring a considerable amount of mineral traffic to the road. To the eastward the Company has completed the Baltimore & Eastern Shore Railroad, which, in connection with the Annapolis Short Line, makes a more direct and shorter connection between Baltimore and the Eastern Shore than has heretofore existed. The most important acquisition of mileage during the year, however, was the controlling interest in the Valley Railroad, from Valley Junction to Cleveland, and the construction of the line from Akron to Chicago Junction, which will shorten considerably the Company's line to Chicago. The last-named line is now nearly finished.

THE terminal line of the Philadelphia & Reading Railroad in Philadelphia is to be built, the consent of the City Council having been at last secured. The plans include an elevated road crossing the streets in the busy portion of the city on bridges, and the construction of a passenger station of ample size, the building itself to be 260 × 90 ft., and the train-house 260 × 575 ft. This will be a great relief to the city in freeing the streets from obstruction, and to the road in providing accommodations for the traffic, for which the present station is entirely inadequate.

HOW great an obstruction to street traffic a railroad may be is shown by the statement that the number of regular trains entering and leaving the Philadelphia & Reading stations in Philadelphia is 290, of which 230 run to and from the main station at Ninth and Green streets, the remainder going to the old station at Third and Berks streets. This does not include freight trains or the crossing of the streets by switching engines. Under existing circumstances constant trouble is unavoidable, and a separation of railroad and street grades has become a necessity which could no longer be postponed.

THE growth of our larger cities creates an enormous traffic which must be accommodated, while at the same time it makes the handling of that traffic difficult. Thus a condition has arisen in which the cost of the terminals of a road may almost equal that of the road itself. Were a new line to be built from New York to Boston, for instance, the two sections of five miles at each end of the road would probably call for a larger expenditure of money than the 200 miles or so which would make up the rest of the line.

NO railroad running out of New York has shown a greater growth in suburban traffic during the past few years than the New York, Lake Erie & Western. The road has an excellent suburban country on its main line and branches; but the growth has been largely due to the great improvements in train service and accommodations which have been made under the present management, which has done much to repair the mistakes of previous administrations in neglecting local business.

THE American plan of regulating railroad time, which has been generally adopted for local time also in this country, is making considerable progress in Europe. In August last the German Railroad Union, at Dresden, voted that, beginning with the time-table changes next spring, uniform time shall be adopted for all the railroads in the Union. The time or hour adopted is the hour of the 15th degree east of the meridian of Greenwich, and this will regulate time on all the roads, regardless of the local changes. As the Union includes all the railroads of Germany and Austria-Hungary, this is a very important step toward the introduction of the system in Europe.

At the same time the Union expressed the opinion that railroad time, as thus established, should be adopted as the general time for all local and civil purposes in the country served by the roads, and it is stated that the Government is preparing a bill for submission to the Reichstag which will carry this recommendation into effect.

Belgium and Holland will shortly adopt the same system, and it has many advocates in France, so that the probabilities are that Europe will before long be governed as to time by this system, which is now so thoroughly established here that no one, we believe, desires to go back to the old plan. In time the consent of all civilized nations will be secured, and the world will be divided into hour zones, the change of an hour at each 15 degrees being recognized everywhere.

IT is proposed to cross the Potomac from Washington to Arlington Heights by a suspension bridge, having a clear height of 105 ft. above the water, with a river span of 1,100 ft. and two shore spans of 652 ft. each. Plans for this bridge have been prepared by the Corps of Engineers, and they provide for approaches at each end composed of masonry arches and earth embankments. The towers for the bridge will be of granite about 210 ft. high, and will in general type resemble the towers of the Brooklyn Bridge. A new bridge is very much needed at that point, and the suspension bridge, as proposed, would not at all interfere with the navigation of the river.

A TEST of English and American locomotives is to be made on the New South Wales Government railroads, where there are a number of engines from the Baldwin Works. The dimensions of the classes of engines chiefly used in freight and general service are :

	Baldwin Consolidation.	Baldwin 10-wheelers.	Beyer, Peacock & Co., 10-wheelers.
Cylinders	21 × 26 in.	21 × 24 in.	20 × 26 in.
Drivers, diameter	51 in.	61 in.	60 in.
Adhesion weight	120,000 lbs.	97,000 lbs.	94,000 lbs.
Total weight	132,000 "	130,000 "	128,000 "
Heating surface	2,000 sq. ft.	1,935 sq. ft.	2,000 sq. ft.
Grate area	28 " "	28 " "	28 " "
Boiler pressure	160 lbs.	160 lbs.	160 lbs.

All the engines have copper fire-boxes and brass tubes. The road on which they work has grades of 130 ft. and 176 ft. per mile, and 11° curves.

The special competitive trial will be made with the ten-wheeled engines. There are 12 from the Baldwin Works, and 50 from Beyer, Peacock & Company, and they will be run together on similar work, and an effort made to have a fair trial on their merits. They are to be tested as to capacity, economy in fuel, and cost of repairs, and the results will be observed with much interest.

COMPOUND LOCOMOTIVES.

IN a review of a report of the performance of a compound and a simple engine on the Brooklyn Elevated Railroad, published in the January number of the JOURNAL, attention was called to what appeared to be incongruous facts in relation thereto. The most noteworthy of these was the performance of the two boilers, the report showing that, with substantially the same trains, the boiler of the compound engine evaporated an average of 8.25 lbs. of water per lb. of coal, whereas the boiler of the simple engine evaporated only 6.69 lbs. In the *National Car and Locomotive Builder* of February, the editor of that publication, as an explanation of this apparent anomaly, says : "There is no question that an important part of the saving effected by a compound over a simple locomotive results from the increased efficiency of the boiler of the former engine."

Probably a good many readers will feel disposed to place an interrogation mark after this assertion, or they will ask that a definite value be assigned to the word "important." Does it mean that 1 per cent., or 25 per cent., of saving is due to this cause, and where is the proof that such a saving, whatever it may be, is due to the cause assigned ?

The explanation given for the saving due to the cause quoted is that "the decreased volume of steam called for by the cylinder of the compound locomotive in performing the work done by the simple engine increases the efficiency of the boiler and has an effect equivalent to enlarging its capacity, since the drain of steam is reduced." Stated as a general principle, this is admitted, but if quantitative values are assigned to the volume of steam and to the efficiency of the boiler, it might be disputed. Thus, the report before us shows that the gain of the compound engine in water consumption was 23.8 per cent. In other words, the compound engine used 23.8 per cent. less water in doing the same work than the simple engine did. It must be kept in mind, though, that the simple engine had a pressure of only 140 lbs., whereas the compound carried 155 lbs. Had the steam pressure in each engine been equal, undoubtedly the difference in water consumption would have been less.

When we compare the rate of evaporation of water per pound of coal, it is seen that, in the compound boiler, 23.3 per cent. more water was converted into steam by each pound of coal than in the boiler of the simple engine. This is attributed by our contemporary, as explained above, to the fact that the boiler of the compound engine was not worked as hard as that of the simple engine, to the softened exhaust of the compound, and to the fact that the exhaust steam escapes up the chimney of the compound in two puffs to each revolution of the wheels instead of four, as in the simple engine. The writer says : "From the experience we have had with locomotives with large and small wheels and all other parts the same, we are inclined to think that, under certain limits, slow exhausts tend to increase the efficiency of the boiler." There are persons whose experience leads them to think just the reverse of this, and who believe that an engine with small wheels and cylinders proportioned to them will make more steam, and do it more economically, than one with large wheels and cylinders—in other words, that many small puffs of steam are better than a few big ones.

The whole argument for the compound locomotive depends upon whether it will do a given amount of work with materially less steam than a simple one will. If, in that respect, there is sufficient saving to compensate for the additional cost and complication of a compound locomotive, the case is proved in favor of the latter ; but what may be called the consequential advantages of a light exhaust and few puffs of steam—if they are advantages—are available on simple engines as well as on compounds.

A skillful writer has so many ways of stating the results of locomotive experiments, he would probably show an economy of fuel as a result of painting the chimney sky blue, if he was interested in producing such a result. Now, no misrepresentation in the report here criticised is charged or intimated. We have no doubt of the fact that the performances of the engines was precisely as reported, but we do not agree with our contemporary that it is a matter of secondary importance "how the thing comes about." It is of the utmost importance to know whether the "thing" is a consequence of the compound system or of some other cause. The experiments seem to have been conducted with great care, but the trial has been made *ex parte*, as the lawyers say. The simple engine had no counsel or advocate, and all of us know the readiness of mind with which we accept evidence favorable to our interests, and the critical spirit that is aroused by that which is unfavorable. Before the results of such experiments as we are criticising can be accepted implicitly, the simple

engine should have an advocate and a friend as well as the compound. It, at any rate, should have the advantage of equal steam pressure, be the advantage much or little. If a compound locomotive consumes less steam than a simple one, and therefore, the demands made on the boiler are less in the former than the latter, and, as a consequence, more water can be evaporated per pound of coal in the one than in the other, it is fair to attribute that advantage to the compound system, although it might still be an open question whether it would not be more economical to put the extra weight of the compound cylinders and other parts into the boiler of the simple engine, and thus enlarge it. A softened exhaust would then be available, and if two puffs per revolution are better than four—of which there is no evidence, excepting that our critic is "inclined to think so"—why, then we could arrange the engine to puff twice instead of four times to each revolution.

What is needed is a series of competitive tests of compound and non-compound locomotives—conducted in a similar manner to the Burlington brake tests of a few years ago—in which slow and fast, heavy and light trains, should be hauled under all the various conditions of actual practice.

If compound locomotives will save 37.7 per cent. of the fuel consumed, it is a matter of the most momentous importance to railroads and to the whole country, and the RAILROAD AND ENGINEERING JOURNAL will be the last to interpose any obstacles in the way of that fact being demonstrated; but when our esteemed contemporary asks us to accept the conclusions of an *ex parte* report as "irrefragable facts," and hold our tongues, we will "keep on exclaiming," and ask for more proof and, if need be, like a Scotch jury, bring in a verdict of "not proven."

PASSENGER RATES IN EUROPE.

FROM a report recently prepared by order of the French Chamber of Deputies, it appears that the average rates of fare in different European countries are as follows, in cents per mile:

COUNTRIES.	First-class.	Second-class.	Third-class.	Fourth-class.
France	4.0	3.0	2.2	......
England	4.1	3.1	2.0]	......
Belgium	3.1	2.4	1.6	......
Holland	3.4	2.7	1.7	......
Germany	3.2	2.4	1.6	0.8
Hungary	2.4	1.6	0.8	......
Switzerland	3.4	2.4	1.7	......
Italy	3.6	2.5	1.6	......
Spain	4.2	3.2	2.0	......
Russia	4.8	3.5	1.8	......

There is a considerable difference in the accommodations afforded the lower classes of passengers in different countries. In England, for instance, second and third-class coaches are carried on nearly all the express trains, while in France and Germany third-class cars are found only on accommodation trains, and on the faster express trains only first-class passengers are taken. The only country having a fourth class is Germany, and the cars of that class are usually attached to freight trains.

Hungary has the lowest rates, probably owing to the zone-tariff system which has been applied in that country with considerable success. Low rates are found in Belgium, Holland, Germany, and Switzerland, all countries where incomes are limited and expenses carefully cut down. Russia, a country where travel is comparatively light, has the highest rates. England and France come next, but they are the two countries which provide the best accommodations for passengers.

As compared with our own country, Belgium, Holland and Germany come nearest to it, their second-class rate being nearly the same as our *average* passenger receipt, while their first-class is not widely different from our regular rate, with sleeping or parlor car charges added. It is not very easy to make a comparison, however, as the rates in different sections of this country differ so much.

The information was collected with a view of assisting the French Chamber in preparing a measure for the regulation and equalization of passenger rates. This proposed law is now under consideration.

HIGHWAY ROADS.

THE Massachusetts Institute of Technology in Boston is to have a course of instruction in Highway Engineering, for which the necessary funds have been provided by Colonel Albert M. Pope, of Boston, a gentleman who has taken an active and intelligent interest in highway improvement. It is hoped that this course will attract a number of students and will be the means eventually of disseminating information as to proper methods of building and maintaining highways.

The short course offered by Vanderbilt University, in Nashville, Tenn., for the instruction of local road officers, has, we believe, met with some success, and has attracted quite a number of the persons for whose benefit it was intended. Such instruction is very much needed, and cannot fail to be beneficial.

The cause of highway reform is making some progress in various quarters of the country. In several counties in New Jersey the adoption of the county road law, which was passed by the Legislature some time ago, has been the means of beginning measures which, it is hoped, will result in permanent and substantial improvement of the highways.

In New York no action was taken on Governor Hill's excellent suggestions by the last Legislature, but it is hoped that something will be done this year, whether by adopting the proposal to build State roads, or by providing for some form of general supervision for the highways. The present condition of the roads in many parts of New York is a disgrace to so wealthy and prosperous a State, and some measure of reform is urgently needed. It is said that the Governor will again call legislative attention to the subject, and will urge it very strongly. The New York State Road Improvement Association, which was organized last year, has been doing something in awakening public interest in the question, chiefly through the efforts of its President.

In Pennsylvania the Commission appointed by the Legislature to consider this subject has prepared a draft for a new law, which will be submitted for action this winter, and which makes as radical changes as were considered at present advisable. The plan in substance provides for the election by the people of three road commissioners for each township, who will appoint the roadmasters of the various districts, the latter receiving pay. The Commission do not feel warranted in recommending at present

the abolition of the system of working out road taxes, but have made the provisions of the law as stringent as possible. Property owners who desire to work out the tax will be required to notify the town commissioner in the spring, and will be required to do their work just when and where they may be directed by the roadmasters; and in case they fail to appear at the appointed time and place, a substitute will be promptly hired, and the delinquent will be obliged to pay the tax. This is intended to obviate the great defect of the present system, under which whatever work is done upon the roads is done when the farmers have most spare time, which is precisely the period when it does the least good.

The defects of this bill are chiefly that it is not radical enough; the system of working out road taxes should be abolished altogether, and more responsible commissioners could probaby be obtained, if a county instead of a township were made the field of their operations. The Commission, however, has probably showed wisdom in advancing slowly, and not trying to do too much at once.

The proposed law provides also a system of what may be called "premiums." For every mile of improved road having a permanent stone or gravel foundation built by the township and approved by the County Commissioners, the county will build an additional mile and the State another, so that any township can secure three miles of new road at the cost of one. This proposition is likely to meet with considerable question in the Legislature, and, in fact, the whole law as presented by the Commission may be considerably modified before passing, should it pass at all.

In some of the Western States also movements in favor of better roads are reported. Public attention is slowly being drawn to the question all over the country, in fact, and in the course of a few years some substantial improvement may be looked for.

BUILDING THE NEW NAVY.

Bureau of Construction and Repair. *Annual Report to the Secretary of the Navy for the Fiscal Year ending June 30, 1890.* Chief Constructor T. D. Wilson, Chief of Bureau.

The building of the new Navy has thrown upon the Bureau of Construction more work during the past two or three years than has fallen to its share at any previous time since the war. The designs of all the new vessels have had to be prepared, the drawings made and furnished to contractors, and a great variety of similar work to be attended to, so that the officers have been very fully employed.

The annual report of Chief Constructor Wilson is a very interesting record of the progress made in naval work during the past year, and also of the present condition of the Navy. That the new ships were not begun too soon is shown by the following extract:

> With the gradual appearance of the new steel navy has come the rapid retirement of the wooden fleet.
>
> When the *Chicago*, *Boston*, *Atlanta* and *Dolphkin* were begun, the serviceable wooden vessels numbered 37 in all; now there are 11 new steel vessels and one first-class torpedo-boat in commission, and only 18 wooden steam vessels.
>
> In about seven years the wooden fleet will have practically disappeared, or have been utilized as receiving and training vessels.

The report is illustrated by a number of drawings of the new ships designed by the Bureau, and by photographs showing the progress made on the vessels under construction. The more important of those designed and begun during the year were Cruiser No. 6, as yet unnamed; Armored Cruiser No. 2, the *New York*; the great three-screw cruiser, at present designated as No. 12, and the three battle-ships, the first of their class for our Navy. All of these ships were designed by the Bureau of Construction, and all of them are described and illustrated in the report.

NEW PUBLICATIONS.

The Theory and Practice of Surveying. *Designed for the use of Surveyors and Engineers generally, but especially for the use of Students in Engineering*; by Professor J. B. Johnson, C.E. (John Wiley & Sons, New York. Price, $4.)

Professor Johnson's work has become so well and widely known since its first appearance, some five years ago, as the standard treatise on surveying, that it is hardly necessary to enter into an extended review here. It is enough to say that it is the most complete and thorough book on the subject, and that it was the first to treat fully, in an elementary way, several important branches, such as City Surveying, Hydrographic Surveys, and Geodetic work. That the present is the seventh edition is fair evidence of its importance.

In this edition some important changes and additions have been made. Part I., on Instruments, has been enlarged by descriptions and cuts of several new instruments, including the architects' level, Wood's double sextant, and the cross-section polar protractor used in the tunnel of the new Croton Aqueduct. Some of the tables have been replaced by later ones worked out by the Coast Survey. The chapter on Land Surveying has been entirely recast, and considerable new matter added. The description of the United States Land Surveys has been rewritten and enlarged. Some new tables have been added, and a method of running out parallels of latitude is also an addition. These changes are the result of experience, which has showed the weaker points of the original work, enabling the author to strengthen them, and to supply what may have seemed to be deficient.

The book is well printed, in type of good size, and the tables especially deserve praise from the fact that they are printed with fair-sized figures and are not as crowded as such work is apt to be. An exception must be made in the case of the tables of natural sines and tangents (VI. and VII.), which would be less trying to the eyes had more space been allowed them. The illustrations are fair; some of them are good, but a few are hardly up to the standard which so excellent a book seems to require.

The defects are not serious, however, and the book is one which would seem to be indispensable for the student, and almost equally valuable to the engineer and surveyor in active practice.

A Manual of Land Surveying: *Comprising an Elementary Course of Practice with Instruments, and a Treatise upon the Survey of Public and Private Lands.* By F. Hodgman, C.E., and C. F. R. Bellows, C.E. (F. Hodgman, Climax, Mich. Pp. 480; price, $2.50.)

This book had its origin in the action of the Michigan Association of Surveyors & Civil Engineers, which referred to a committee the task of preparing a manual which should give authoritative answers to the many perplexing question constantly arising in a surveyor's practice. To this end, the many decisions of the courts in relation to surveys were carefully collected and digested, so as to give as fully as possible all the points in relation to surveys and boundaries which are likely to arise in ordinary work. This has not been done at the expense of the mathematical part of the work, and the latter has been given at sufficient length to make it serve as a text-book for the student, or as a companion for the surveyor.

The book, as first issued, has stood the test of time, and the fifth edition is now issued, revised by Mr. Hodgman, and with some additions.

The various chapters treat of Instruments; Measurements; Platting and Computing Areas; Curvilinear Surveying; Original Surveys, including those of the public lands; Subdivision of Sections; Resurveys; Relocating Lost Corners; Map-making and Leveling. A supplement contains the usual tables.

It is a thoroughly practical book, and must be appreciated by the land surveyor, who so often needs a guide which will give him in condensed and intelligible form the law of the cases which he is constantly meeting, by which his action must be governed. Much often depends on his action, and it is important that it should be correctly taken in all respects.

EXAMINATION OF WATER FOR SANITARY AND TECHNICAL PURPOSES. By Henry Leffman, M.D., Ph.D., and William Beam, M.A. (P. Blakiston, Son & Company, Philadelphia. Price, $1.)

The examination of water and the decision as to the best sources from which it is to be obtained are questions which often meet the engineer in practice, and which he cannot always obtain the aid of the chemist to decide. Very often also points of considerable importance may be affected by the water supply, such as the location of water tanks on a railroad, the choice of a place for a division station and shops, and the like. The aid of the chemist should, of course, be called in wherever possible; but it is well for the engineer to know something of the best methods to be adopted in examining water, and of the qualities which make it available or otherwise for his purposes.

Something may be judged of the scope and plan of this book by the titles of its chapters. They are on History of Natural Waters; Analytical Operations; Interpretation of Results; Biological Examinations; Purification of Drinking Water; Identification of Source of Water; Technical Applications; Analytical Data. The chapter on Technical Applications includes the definition of the qualities which affect water to be used in boilers and the methods adopted for purifying water for this purpose when necessary.

The engineer engaged on water works will find of especial interest the sections on sanitary applications, on biological examinations, and on the latest methods adopted for purifying drinking water. The practical applications are numerous, and will readily suggest themselves.

Especially valuable is the section on interpretation of results, for, as experience has often shown, it is easier to make a test, in many cases, than to use properly the lessons which the test should teach.

PRELIMINARY SURVEY AND ESTIMATES. By Theodore Graham Gribble, C.E. (Longmans, Green & Company, London and New York. Illustrated, 420 pages; price, $2.25.)

An English technical book which is, confessedly, based to a considerable extent on American methods, is somewhat of a rarity, but it is found in this case. The author has apparently seen practical service in Canada and Australia, and he criticises English methods of instruction in his preface even more severely than an American would be apt to do. The young English engineer, he thinks, is not, as a rule, sufficiently trained in practical methods; his ideas have not sufficient flexibility, and he is too much inclined to look with disfavor on everything which differs from English work. The consequence is that in new countries, even in the English colonies, the door is closed to the English engineer as soon as men can be trained abroad. This tendency he wishes to change. Something of the general plan of his book may be learned from the following extracts from his preface:

> In simplicity of survey practice, uniformity of gauge, types of bridges, and rolling stock, the American engineer may be profitably (though not slavishly) imitated in the work of opening out a new sphere of enterprise . . . . .
>
> The methods of surveying considered in the following pages are by no means exclusively American. In the class of work formerly called telemetry, but now tacheometry, we have to go to Italians, French and Germans for most of the original conceptions, and the best modern developments. Comparatively few English engineers really practise these methods unless they have learned them abroad, although some are thoroughly proficient in them.
>
> The title of this book, "Preliminary Survey," is American, and answers somewhat to our "Parliamentary Work;" but it covers a wider range—in fact, the whole science of surveying in a condensed form, with the exception of those minute details where very great accuracy is required. . . . . .
>
> Considerable use has been made of standard authorities on both sides of the Atlantic, but the subject-matter is in the main the result of actual experience. The necessary compactness of such a work has made it eclectic. Some methods have been passed over with slender comments, although occupying much space in other text-books. On the other hand, such subjects as tacheometry, computation by diagram and slide-rule, signaling, etc., which are as yet hardly known to the general public, except in pamphlet form, are here treated of at considerable length.

On these lines Mr. Gribble has produced a book which is worth study. The criticisms of a friend should be profitable, and it is well to know how our own methods appear to one who has been trained in others. Much is also to be learned by combining different systems, and a wise eclecticism is, perhaps, the best of all methods.

The chief subjects treated of, after the general introduction, are Reconnoissances; Hydrography and Hydraulics; Geodetic Astronomy; Tacheometry; Chain Surveying; Curve Ranging; Graphic Calculation for Preliminary Estimates; Instruments. An appendix contains tables for curves and spirals.

Perhaps the chapters on Reconnoissance and on Tacheometry are the most interesting; but there is much to be found that may be carefully read, and the book will repay attention given to it by engineers, even if they do not always agree with the author.

A STUDY OF COMBUSTION. By C. Chomienne, Engineer of the Couzon Forge. (Imprimerie Chaix, Paris.)

This is a reprint of a paper prepared by M. Chomienne, with some of whose work our readers are familiar, for the Society of Alumni of the French National Schools of Arts and Trades. That is is a thorough and carefully executed piece of work need hardly be said, when speaking of the author. His object has been to consider the subject of Combustion in the light of the latest experience and the latest experiments. Especial weight is given to the latest forms of fire-boxes, and to devices for ensuring complete combustion of fuel; to tubulous and other types of boilers for high-pressure; and to the use of liquid and gaseous fuels. Some prominence is also given to the necessity—more felt at present in France than in this country—of the closest economy in the consumption of fuel, and the complete utilization of the heat produced by its combustion in the boiler, a point to which too much attention can hardly be given.

NEW ENGLAND ROADMASTERS' ASSOCIATION: *Proceedings of the Eighth Annual Convention, held in Boston, August* 20 *and* 21, 1890. (The Association, Northampton, Mass.)

This report contains much matter of interest to engineers and roadmasters, including reports and discussions on Maintenance of Track, Inspection of Road-bed, Frogs and Switches, and Ties. The members evidently have among them many active and observant men, whose notes of experience are of value and interest, and who are not afraid to bring them out before the convention.

The progress made by the Association is shown by a glance at this report and the *Proceedings* for the previous year. Size alone is not always a test of a book, but in this case the report has almost doubled in size without any diminution in excellence. The Association is to be congratulated on the evidence thus presented of growing activity and usefulness.

Master Mechanics' Association: General Index to the Annual Reports. *Covering the Reports from the First to the Twenty-third, Inclusive*—1868–90. Prepared by Angus Sinclair, Secretary. (The Association, New York.)

The preparation of this Index was undertaken by Secretary Sinclair in accordance with a resolution passed by the Association last year. It is hardly necessary to say that it will be of great service to those members and others who preserve their reports and have occasion to refer to them. An editor especially appreciates the time and labor spent in searching for a report or paper through a series of volumes; and he also appreciates thoroughly the care with which Mr. Sinclair's work has been performed, and the time and trouble required for such a task.

TRADE CATALOGUES.

Central Station Electric Lighting Plants and Electric Railroads of the United States. The Thomson-Houston Electric Company, Boston.

This book consists of a series of outline maps of the United States, showing the cities where electric lighting plants are in operation, the marks on the map indicating what system is in use in each place. A second series, on a somewhat smaller scale, shows the cities which are provided with electric railroads, the system in use being also indicated on these maps. These maps are accompanied by some pages of tables, giving the number of central station lighting plants of different systems, and also the number of electric railroads in operation.

The map is very convenient for use by those who are interested in electrical matters. The maps are interspersed with advertising pages, which are chiefly taken up by manufacturers of electrical apparatus, and of steam-engines and other auxiliary machinery.

Staunton, Virginia: its Past, Present, and Future. The Staunton Development Company.

This book is intended to make known to the world the advantages and prospects of the town of Staunton and the adjacent country. This is done by a well-written historical sketch and a general description. The best part of the book, however, is the illustration, which includes a number of views in and about the town and in the adjoining country. Most of these are from photographs, and they include some of the best work of the kind we have ever seen. They certainly give the reader an excellent idea of the place, and are a most attractive advertisement.

Illustrated Catalogue of the Decauville Portable Railroad. Petit-Bourg, France; La Société Decauville Ainé.

Van Vranken's Automatic Flush Tank for Flushing Sewers, Drains, etc. Schenectady, N. Y.; Benjamin Van Vranken.

BOOKS RECEIVED.

Reports of the Consuls of the United States to the State Department: No. 122, *November*, 1890. Washington; Government Printing Office.

European Emigration: Studies in Europe: by F. L. Dingley, Special Consular Report to the State Department. Washington; Government Printing Office.

Compound Locomotives: by Professor Arthur T. Woods, M.E. New York; R. M. Van Arsdale (price, $2). This book is received too late to give it the comment which it deserves, in the present issue.

Annual Report of the Postmaster-General of the United States for the Fiscal Year Ending June 30, 1890. Washington; Government Printing Office.

Cornell University, College of Agriculture: Bulletin of the Agricultural Experiment Station, No. XXV, December, 1890. Ithaca, N. Y.; published by the University.

Proposed Tennessee Highway Law. Nashville, Tenn.; the Nashville Commercial Club. This is a draft of a very excellent act prepared by a committee of the Nashville Commercial Club, and submitted to the Tennessee Legislature.

Eighteenth Annual Report of the Commissioner of Railroads, State of Michigan, for the Year 1890: *John T. Rich, Commissioner.* Lansing, Mich.; State Printers.

Facts and Figures about Norfolk, Va. Compiled and issued by the Chamber of Commerce.

Report of Committee on Roads and Draft of Proposed Road Law. Pittsburgh, Pa.; the Western Society of Engineers.

American Shipbuilding and Lake Transportation: by Joseph Oldham, C.E., Naval Architect. Cleveland, O. This is a comparison between the design, construction and general efficiency of the freight steamers used on the great lakes and foreign cargo steamers.

Eighth Annual Report of the Board of Railroad Commissioners of Kansas, for the year ending December 1, 1890: *James Humphrey, George T. Anthony, Albert R. Greene, Commissioners.* Topeka, Kan.; State Printers.

ABOUT BOOKS AND PERIODICALS.

In the Popular Science Monthly for February, Mr. Durfee's articles on the Developments of the Iron Indrustry in America are continued by a paper on Iron Smelting by Modern Methods, which, like the previous articles, is very fully illustrated. Another illustrated article is on Progress in Agricultural Science; and Mr. Charles Morris has an interesting paper on the Storage of Cold. The Editor makes a strong appeal in favor of the International Copyright Bill.

The military article in Outing for February gives a description of the Active Militia of Canada. The Racing Canoe and its development are discussed by Mr. Vaux, and the articles on Photography are continued.

The third of Sir Edward Arnold's articles on Japan appears in Scribner's Magazine for February. These articles will be concluded in the March number of this Magazine, and in that number also will be an account of the National Geographic Society's Explorations of Mount St. Elias, made last summer. The Practical Means of Ornamenting Ponds and Lakes will be discussed by Samuel Parsons, Jr., Superintendent of the New York Parks.

The Stevens Indicator for January includes articles on Cable Traction on Elevated Railroads, by Charles W. Thomas; Marine Governors, by J. Hansen; Measurement of High Temperature, by W. A. Ebsen and E. W. Frazar, with several other articles of interest, including the Use of Electricity in operating cranes and machine tools, and a note on the performance of the double-screw ferry-boat *Bergen*.

In the Arena for February, M. Camille Flammarion, one of the most eminent of European astronomers, writes on New Discoveries on Mars, the paper being accompanied by a full-page map of that star, and smaller maps showing recent apparent changes on its surface. Mr. C. Wood Davis discusses the Farmer, the Investor and the Railroad, studying the railroad problem from a point of view which is rather that of the farmer than of the railroad owner or manager, but presenting some facts and arguments which deserve consideration.

Among the books now in preparation by John Wiley & Sons is CONSTRUCTIVE STEAM ENGINEERING, by Professor Whitham, whose book on Steam Engine Design was published not long ago by the same firm. The object of this book is to treat the constructive features exhaustively, not discussing design, but presenting the constructive details, the various forms of valve gear, and the different types of engines and boilers in use.

In HARPER'S MAGAZINE for February the descriptive articles include one on Finland, a country whose geography, history and people are but little known in this country, but present some very interesting points. Mr. Child's South American articles for this month takes in the Straits of Magellan, including a sketch of the coast from Peru southwest to the Straits on the Atlantic side from the Straits northward to Montevideo. In the Heart of the Desert, Mr. Warner gives an account of a visit to the Pueblos of New Mexico, and the Grand Cañon of the Colorado. All these articles, as well as a number of lighter articles in the number, are profusely illustrated.

In BELFORD'S MAGAZINE for February there is the usual variety of lighter reading, with some more solid matter. This magazine is, as usual, plain and outspoken in its editorial opinions, and no one of its readers need be in doubt as to where it stands on any question of current importance.

ENGLISH LOCOMOTIVE PERFORMANCE.

To the Editor of the Railroad and Engineering Journal:

I NOTICE that you quote the London *Engineer* as stating that the maximum coal consumption of an English engine is 75 lbs. per square foot of grate surface per hour. There is some mistake about this figure, for 100 lbs. is reached in daily working of both freight and passenger trains. Taking an English freight train running full speed, say 35 miles per hour, on a fairly level road, the consumption of coal will be from 45 to 50 lbs. per mile or averaging say 1,700 lbs. per hour. As the grate area in English engines is rarely over 18 sq. ft. in passenger express engines, or 17 sq. ft. in freight engines, this gives about 100 lbs. as a very usual performance in daily work, often for over one hour at a time.

An express engine running over a similar road at 55 to 58 miles an hour will burn from 27 to 35 lbs. per mile, giving say 1,000 lbs. per hour, which is 100 lbs. per hour per square foot of a grate of 18 sq. ft. area.

I notice the *Engineer* in a recent issue quotes the results of some experiments made by me 13 years ago on the North British Railway when I was Assistant to the then Locomotive Superintendent, Mr. D. Drummond. While I took every care that the results should be accurate, they cannot be said to represent the average performance of an English good engine. The experiments were made for the special purpose of testing the relative economy of pumps *versus* injectors, the water being heated by the exhaust steam where the pumps were used. As the engines in other respects were precisely similar, the results obtained were fair comparisons between pumps and injectors, but for the following reasons did not represent what these and other English engines are capable of in actual practice.

The engines were of a pattern new on that line, and the firemen were much puzzled by the great slope of the grate and the peculiar position of the ash-pan damper. They consequently had difficulty in keeping steam, and at the time the experiments were made the blast-pipe nozzle was unduly contracted, thus creating an increased back pressure and somewhat cutting and wasting the fire. Some months afterward, when the men understood the engines, they did far better, steamed admirably, burned less fuel and hauled heavier loads.

It will be seen that under these circumstances the experiments hardly represent average performances, which I am satisfied in general practice give fully 8½ lbs. of water per pound of coal, while over 9 lbs. is often attained by good firing.

I dare say it will be a matter of surprise that these engines only exerted a tractive force equal to about one-seventh or one-eighth of their adhesion weight. The Scotch climate, however, is damp and misty, and as a matter of fact, we never ascended one grade of 53 ft. per mile near the border between England and Scotland without some slipping, though the steeper grades (75 ft.) were often surmounted without a slip.

The proportion of adhesion to tractive power differs largely with climate, and I may mention that here I have found that the maximum tractive power the engine is ever capable of exerting (the average pressure in cylinders being 85 per cent. of the boiler pressure) should be not more than one-quarter of the weight on the drivers. We have some engines in which it is $\frac{1}{3.77}$ and they slip so badly that they are being altered, the cylinders being reduced 1 in. in diameter. This slight change cures the slipping, showing that the coefficient of adhesion is more sensitive and more exact, in this climate at any rate, than many suppose.

I may add that the loads taken represent with tolerable accuracy the average loads in actual practice on British lines. They are, of course, very light as compared with those in American practice, but it is well known that this is due to a variety of causes, the chief being the higher speed at which freight trains are run in order to meet competition and keep out of the way of the numerous fast passenger trains.

I have been tempted to write these lines thinking possibly that you may have founded some arguments on premises which need a little explanation and qualification.

D. H. NEALE,
Mechanical Engineer, New South Wales Railways.

ARGENTINE RAILROADS.

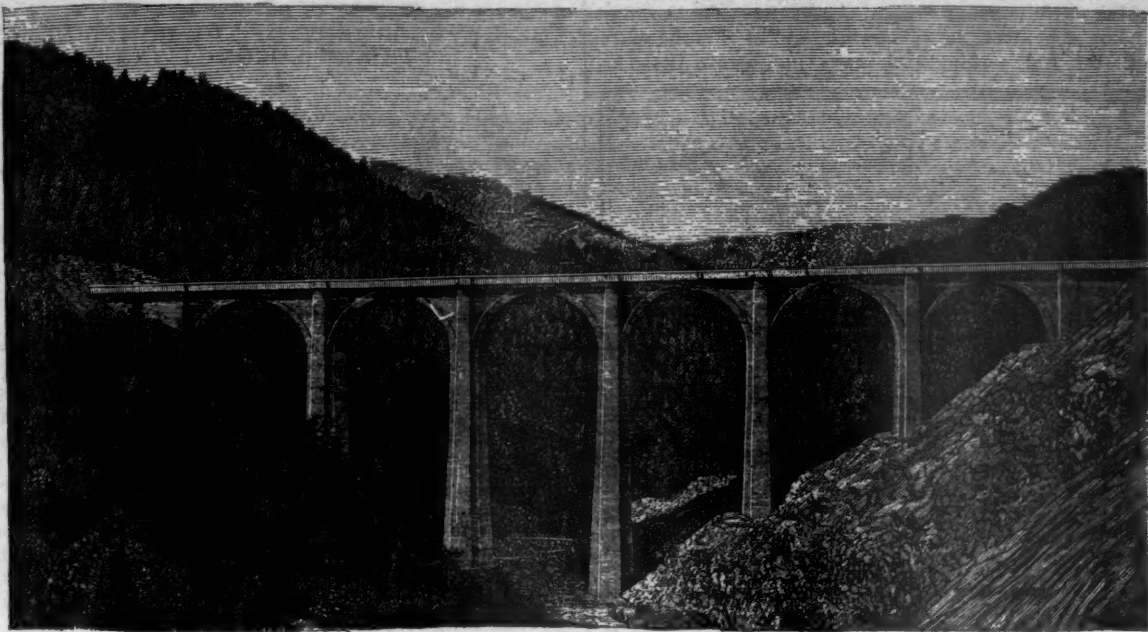
THE total mileage of railroads in operation in the Argentine Republic at the close of 1890 was 5,747 miles, an increase of 732 miles over the length in operation at the close of 1889. In addition to this mileage there were at the close of year the 1,170 miles under construction, and so nearly completed that they will probably be in operation during the present year. These railroads represent a capital of $260,000,000 gold value. About 320 miles of road belong to the National Government and 170 miles to different provincial Governments; the National Government, moreover, guarantees the interest on the bonds and stock of Pacific, the Argentine Great Western, the Eastern and the Central Northern Companies. The increase in mileage for several years past has been very rapid, and railroads have been pushed out in all directions, the most important line perhaps being the Pacific road, the extension of which is now under construction over the Andes to connect with the Chilian system.

At the close of 1890 there were in use on these railroads 436 locomotives, 280 baggage and 500 passenger cars, and 10,525 freight cars. There was a considerable increase in equipment in the course of the year, most of it being imported from Europe, but in comparison with the length of road the rolling stock does not indicate a heavy traffic.

The roads at present are not by any means in a satisfactory condition, owing to the general business and financial collapse which recently occurred. In some parts of the Republic business is almost at a standstill, and the condition of the currency is so unsatisfactory that it is difficult for many of the companies to say what their returns really are. It is also true that in some directions the railroads have been built ahead of business, and while the growth of the country has been great and settlement rapid, it has not been sufficiently so to supply business for all the new lines. Moreover, some of the provinces have suffered from drought and locust, so that the crops have been very light, and the railroad outlook for the current year is not by any means a good one. If the financial affairs of the Government and of the several provinces can be arranged, there is little doubt that in course of time the growth of the country and the solid elements of prosperity which it contains will bring about a better condition of affairs, but for the present it must be considered that new railroad building is at an end, and little or nothing will be done in that direction for two or three years to come.

THE CRUEIZE VIADUCT.

THE accompanying illustrations, from *Le Genie Civil*, show the viaduct which carries the Marvejois-Nessargues Branch of the Midland Railroad of France over the deep valley or ravine of the little river Crueize—a valley so



THE CRUEIZE VIADUCT.

deep, rocky and deserted that it is locally known as the Valley of Hell.

The viaduct consists of six equal arches of masonry and is 218.8 meters (717.7 ft.) long; the height at the center, above the river bed, is 63.3 m. (207.6 ft.). It carries two tracks, which are at that point on a grade of 2.75 per cent., or 145.2 ft. to the mile.

The arches are 25 m. (82 ft.) span; in order that the springing of the two adjacent arches may be on a level, the radius of the lower half of each arch is 12.915 m. (42.4 ft.) and of the other half 12.085 m. (39.6 ft.). In the accompanying illustrations the first is a general view of the bridge; fig. 2 is a longitudinal section through two of the arches; fig. 3 is a half cross-section through a pier, and fig. 4 a half cross-section through the center of an arch.

The foundations presented no difficulty, as the rock is everywhere near the surface. The piers are of the buttressed form shown by the engraving. They are all 11.55

m. (37.9 ft.) extreme length, by 5.20 m. (16.1 ft.) extreme width, at the springing of the arch; their size at the foundation varies according to the height. The batter of the faces varies with each 5 m. (16.4 ft.) of the height, making the face of the pier practically a curve. This system has been adopted in a number of the larger French viaducts. The curve corresponds to the total pressure on the pier. The highest pier is 45 m. (147.6 ft.) from the foundation to the springing of the arch. The greatest depth to which it was found necessary to carry the foundations was 19 m. (32.8 ft.) below the surface; the average depth is 6.5 m. (21.3 ft.).

The construction of the road-bed is shown in figs. 2, 3 and 4. The ballast rests on broken stone filling, above the masonry.

The viaduct contains in all 894,645 cu. ft. of masonry, not including the foundations. Its total cost was $247,680, including clearing and foundation work. It is certainly a very symmetrical and handsome work in appearance.

RAILROADS IN SIAM.

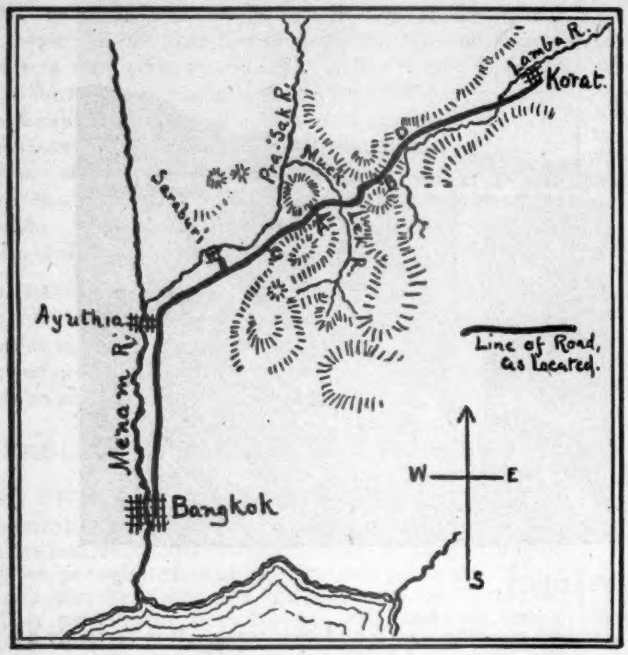
THE fact that the Government of Siam has advertised for proposals to build a railroad, and that some effort has been made to get bids from American contractors, will give interest to the following notes from our correspondent in Siam:

The line for which bids are asked is to run from Bangkok northward to Ayuthia, and thence northwest to Korat, a distance of about 167 miles. For about 47 miles the road runs through the low alluvial plains of the Menam, where embankment will be necessary to keep it above flood level; then for 37 miles over level plain country. The next section of 27 miles includes the ascent from this plain to a high table-land, nearly 1,000 ft. above sea level; the summit, as located, is 1,292 ft. above sea level. The remaining 56 miles to Korat is over nearly level table-land.

The gauge of the road is to be 4 ft. 8½ in. Bids, which are to be sent to K. Bethge, Director-General of Railroads at Bangkok, may be for a section or the whole line. The time allowed is from four to five years; the Government will furnish rails and equipment. The bridges will be of wood and the rails 56 lbs. to the yard. The approximate

estimates show about 4,860,000 cub. yds. earthwork; 260,000 cub. yds. rock-cutting; 6,600 cub. yds. retaining walls, and 66,000 cub. yds. bridge masonry.

The accompanying sketch map will give some idea of the line. The Menam is the great river of Siam and is navigable for large vessels. The Pra-sak is navigable for small rice-boats to Saraburi; the Muck-lek and the Lamba are in no sense navigable. The Lamba is a tributary of the Mekong, the great river of Cambodia. On the map at the point *A* is a secondary summit, and at *B* is the main summit; the rock-cutting and heavy jungle are between



the points marked *C* and *D*. The maximum grade is 1.5 per cent., to be equated for curvature; 15° curves are allowed.

The features which differentiate this work from ordinary railroad construction are:

1. Transport of machinery, tools, etc., 8,000 miles; this is by sea, as large vessels can land at Bangkok.

2. Extreme unhealthiness of the country, especially the district known as the "Fire God's Jungle," where all the heavy rock-work is.

3. Scarcity of labor, which is increased by superstition, by occasional interference of petty officials, and by the fact that the natives can get along with scarcely any money, and consequently do not feel the necessity of earning wages.

4. The surprising density of the jungle and the entire absence of roads for wheeled vehicles.

That work can be carried on in Siam is already proved, this Korat line having been surveyed and located at a cost of not much over $200 per mile, including preliminary work and office expenses.

Labor costs about a half-tical—say 25 cents—per day. The country people are generally honest, and when well treated and forced to take care of themselves, become quite satisfactory, at least so far as their *intentions* go. Working hours are generally from 6 A.M. to 2 or 3 P.M., with a half-hour interval. I have, however, habitually worked men longer than that without difficulty. Much risk would attend the importation of labor, owing to malarial fevers; possibly some Madrasee or Bengalee people might be proof against these, but the only strangers I have ever found able to stand the jungle air and water are Pegus and Tongsoos from Burmah. These men cost me about $15 per month each.

The Siamese Government has the character of paying surely, though somewhat slowly. The proposed railroad is a much greater financial flight than anything they have so far undertaken.

As to other enterprises, the Borapah Railroad Company is still asking for stock subscriptions, but without much success, as no railroad is likely to succeed in Siam except as a Government line or by foreign capital. The proposed line is from Bangkok east to the Bangpakhong River; it will run through an agricultural district, where the traffic is now served by canals of small dimensions, the boats being able to carry 10 or 12 tons only. The chief product of the country is rice.

THE DEVELOPMENT OF THE COMPOUND SYSTEM IN LOCOMOTIVES.

BY M. A. MALLET.

(Paper read before the Société des Ingenieurs Civils, Paris; translated from the French by Frederick Hobart.)

(*Continued from page* 73.)

STARTING APPARATUS.

THE locomotives of the Bayonne-Biarritz Railroad have a starting valve placed on the left side of the smoke-box, the opening of which, determined by the action of the engine man on a screw or lever, permits the engine to work with direct admission to the small cylinder only, and exhaust from that to the large cylinder, or with direct admission to and exhaust from both cylinders; in the latter case the pressure on the piston in the large cylinder is reduced, in relation to the boiler pressure, either by throttling the steam or by an automatic reducing valve. This works very well, but two objections can be made to it, one that it is somewhat large and cumbrous in the heavy engines to which the compound principle is now applied; the other, that it requires considerable force to work it.

The form, but not the principle, of this valve was modified on some engines on the Southwest Russian Railroad, where M. de Borodine used a cylindrical valve or piston valve. The second objection was met by working the valve by a small steam cylinder, to start which requires only the turning of a small valve by the engineer.

In 1884 I presented a much more compact arrangement, which can be worked by the engine-driver, and without the exertion of any considerable force; this is shown in figs. 5 and 6, and consists of a chest or valve-box placed on the left side of the smoke-box. To this valve-chest are attached the exhaust-pipe of the high-pressure cylinder; the pipe leading to the low-pressure cylinder and forming an intermediate receiver, and the exhaust pipe leading from the small cylinder to the smoke-stack. In the valve-chest is a large valve which can close the passage from the small cylinder to the receiver when moved into the right position. On the same valve-rod is fixed a small valve balanced by a piston, and serving to open or to close the communication between the smaller cylinder and the exhaust, according to the position of the large valve.

This position is determined by the pressure existing in the intermediate reservoir.

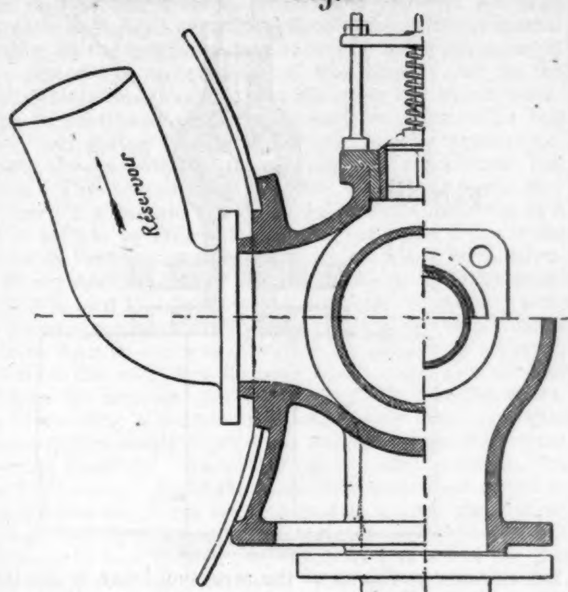
If by the use of an auxiliary throttle valve placed on one side of the smoke-box, steam is admitted directly from the boiler into the reservoir at a pressure reduced either by a special valve or by throttling, this pressure closes the large valve and opens the exhaust valve, and the engine will then work as an ordinary engine. If we close the admission of live steam to the reservoir, the pressure will decrease and will cause a difference, which, combined with the pressure exercised upon the interior face of the large valve by the exhaust steam from the small cylinder, will open this large valve and close the small one, so that the working will be changed to that of a compound locomotive.

The change is determined by the working of what we have called the auxiliary regulator, which requires only the movement of a small lever by the engineer with a very slight exertion. In order to prevent a possible movement of the valves which would cause a loss of steam by direct exhaust to the chimney, and to make at the same time the change from simple to compound working more quickly, the auxiliary regulator is arranged in the manner shown in fig. 7. The valve *a* opens or closes, according to its position, the passage admitting live steam to the intermediate

reservoir. The nut securing this valve has a passage *n* opening outside, or in another position of the nut communicating with steam from the boiler. The tube *m* is carried back to the valve-box at a point in front of the balanced piston, as shown in fig. 6.

It follows from this arrangement that if, the apparatus being in the position shown in fig. 6, the valve is moved into the position shown in fig. 7, steam enters the inter-

Fig. 5.



mediate reservoir and tends to close the large valve, while the space in front of the balanced piston being put in communication with the outside through the pipe *m*, the opening in the valve and the hole *n*, there is no resistance upon this piston. If, on the other hand, the engine is working directly, and the admission of live steam to the reservoir is then closed, there will be in front of the balanced piston a pressure of steam coming from the boiler which secures the opening of the large valve and the

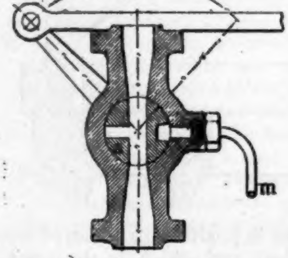


Fig. 7.

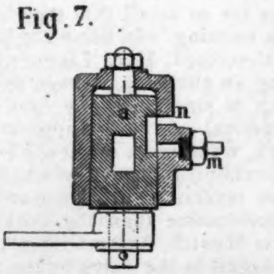
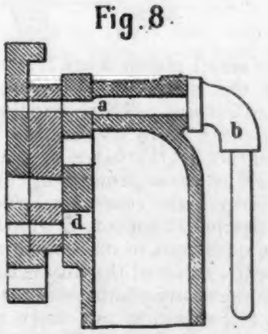


Fig. 8.

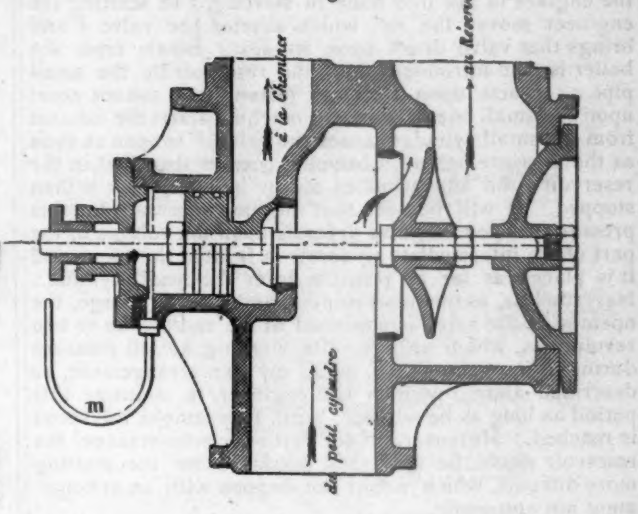


change to compound working. Moreover, as has been said above, this pressure prevents any movement of the valves while the engine is running.

This arrangement has worked in a very satisfactory way. It was applied on a number of large engines in France, in Switzerland and in Austria, and it was used on the six-wheel compound locomotive of the French State Railroads exhibited at Paris in 1889.

By this arrangement, the change from simple to compound working is made by the engineer, but it can, if desired, be made automatic. It is possible, at least in certain engines, to make the throttle valve in fig. 7 work by an arrangement similar to a speed regulator, in such a way that compound working would be immediately produced as soon as the speed of the engine passed a fixed minimum, and that, on the other hand, the engines when stopped would be always ready to start, with direct admission to both cylinders. This arrangement is applicable to tram-

Fig. 6.

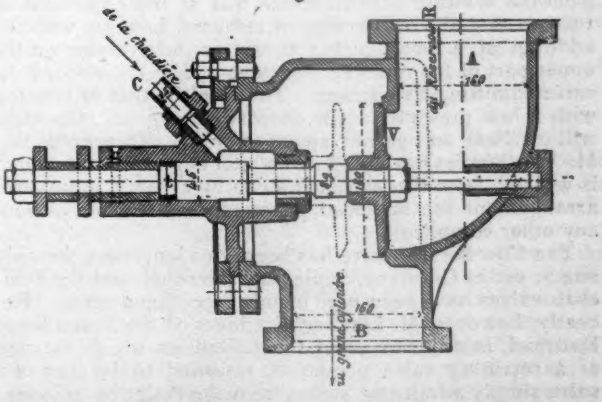


way locomotives and to certain others which have to start with a full opening, such as yard engines.

The valve-chest which has been described carries on the side which is in communication with the intermediate reservoir a safety valve set at a certain point, the object of which is especially to prevent the consequence of the closing of the large valve by counterpressure while running. Instead of having the two valves upon the same rod, they can be arranged side by side with the rods joined by a lever, and this plan has been adopted in Russia.

In his first machines, M. Von Borries, to avoid altogether direct working even in starting, and seeking an ex-

Fig. 9.



cessive simplification, used a regulator shown in fig. 8. In this a small passage *a b* leads the live steam to an intermediate reservoir. The drawing represents the apparatus at the moment of starting, when the steam reaches at the same time both cylinders, the small one by the passage *d* and the large one by the passage *a*. If the throttle valve is opened further by raising it, the opening *a* is closed, while the passage of steam to the small cylinder is opened wider. In the lowest position of the valve, all the openings are closed.

If this apparatus showed itself sufficient for the small

locomotives for general service on which it was first applied, it is not the same for larger engines, and after several trials M. Von Borries adopted an arrangement which allowed him to start with full boiler pressure on the small piston instead of having only the difference between that pressure and the pressure in the intermediate reservoir. This arrangement consisted in the interposition at a point in the reservoir of a valve which prevents pressure of steam in the reservoir from reacting on the small piston. This arrangement is very much the same as my own, described above, and is, moreover, later, if we can judge by the dates of patents.

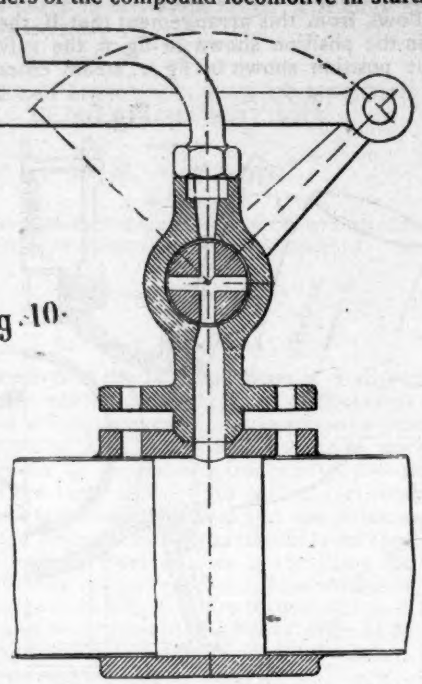
Fig. 9 represents an intercepting valve which permits the engines to act like mine in starting. In starting the engineer moves the rod which carries the valve *V* and brings that valve down upon its seat. Steam from the boiler is then introduced into the reservoir by the small pipe *c*; it acts upon the large piston, and cannot react upon the small one. When the machine starts the exhaust from the small cylinder causes the valve *V* to open as soon as the pressure behind it becomes greater than that in the reservoir; the admission of steam by the pipe *c* is then stopped. It will be seen that the time necessary for this pressure to open the valve depends upon the volume of the part of the intermediate reservoir in front of the valve, and it is placed as far as possible from the small cylinder. Nevertheless, as this reservoir can never be very large, the opening of the valve is produced at the end of one or two revolutions, which only permits working at full pressure during a very short time, while my own arrangement, as described above, permits the engineer to continue this period as long as he wished; until, for example, full speed is reached. Moreover, under certain circumstances, the reservoir would be filled and would render the starting more difficult, which would not happen with an arrangement not automatic.

M. Polonceau has described some modifications of this arrangement where a hinged valve replaces the intercepting valve. This is the system employed by M. Worsdell. Later, M. Lapage, I believe, changed the arrangement by doing away entirely with the lever, and it is the pressure of steam itself which closes the large valve and permits steam from the boiler to enter the intermediate reservoir until the pressure of the exhaust steam from the small cylinder becomes sufficient to open the large valve. This is called by M. Polonceau the "Von Borries valve." Mr. Urquhart uses on his passenger engines a system working like mine, but much more complicated; it requires the working of several levers to close some valves and open others.

The arrangement used on the compound locomotive from the Winthur Works, which was at the Exposition in 1889, is that of Von Borries, or rather of Lapage, with the addition of a small piston to aid in the pressure on the upper part of the intercepting valve and to keep closed the valve admitting live steam. The result is that in running with a low pressure, as in descending a grade, the valve will oscillate and permit steam to enter. To prevent this M. Von Borries has added in his later engines a stop which is worked from the engineer's cab by a rod. In my own arrangement the balanced piston does this work without any other complication.

The Von Borries valve has been for a long time the only one in use in Germany, while the Henschel and the Schichau valves have been used in only exceptional cases. Recently, however, M. Lindner, Engineer of the Saxon State Railroad, in order to avoid the difficulties which the use of a retaining valve presented, returned to the plan of a valve simply admitting steam from the boiler by an opening in the intermediate reservoir at the moment of starting; but in order to prevent the necessity of a separate movement by the engineer, this is arranged in a peculiar fashion. The valve has two passages placed at right angles in such a way that the passage is opened at the extreme positions and closed in any intermediate position. This valve is worked by a lever which is joined to the reversing lever or the reach-rod. The valve is opened when the reversing lever is at an extreme position corresponding to an admission of 80 per cent., and is closed when the lever is thrown back to the position corresponding to about 72 per cent. admission. Fig. 10 shows this arrangement, which is employed on some of the machines on the Saxon State Railroads. It may be curious to note here that this idea of admitting steam directly from the boiler into the large cylinders of the compound locomotive in starting, by

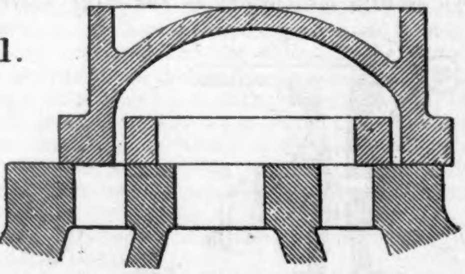
Fig. 10.



the extreme positions of the reversing lever, is clearly indicated in an English patent—that of Dawes, No. 1,857 of the year 1872—that is to say, at a time before the first applications of the principle of double expansion to locomotives.

To avoid reaction of the steam thus introduced in the intermediate reservoir upon the small piston and to provide for the absence of a retaining valve, Herr Lindner makes in the slide-valve two small holes of about 1 sq. cm. in section, as is shown in fig. 11. In starting, steam from the intermediate reservoir can thus reach the two faces of

Fig. 11.



the small piston when it is not in position to be acted upon by the steam from the boiler, and which is thus put in equilibrium. These openings are so small that they have no effect when the engine is running. In some engines, instead of the valve above described, Herr Lindner has used an arrangement opening an auxiliary passage to the intermediate reservoir, which is similar to the first arrangement adopted by Von Borries. As to this apparatus, the questions in discussion are, whether its efficiency is as great as that of the automatic retaining valve, and whether the necessity of throwing the reversing lever forward to its full extent is not more troublesome than the working of a small lever. Krauss, at Munich, has modified this apparatus, replacing the passages in the valve by the addition between the valve and the intermediate reservoir of a small valve, or rather of a flat plate which receives its motion from the cross-head of the small cylinder. When the piston is about at the middle of its stroke—that is, in position to start—this plate closes the passage of steam from the boiler to the intermediate reservoir and prevents any counterpressure behind the small piston; if, on the other hand, it is at the end of the stroke, the large piston

is in good position, and the plate, opening the passages at the end of its course, allows steam from the boiler to enter the intermediate reservoir and consequently the large cylinder. This ingenious arrangement produces the same effect as an intercepting valve, but it is complicated, and requires the use of parts continually in motion.

The arrangements of the throttle valve in fact can be multiplied indefinitely, as each builder and each master mechanic has his own.

To resume the main question: On one side we have automatic apparatus permitting the starting without special working by the engineer, but reducing to an exceedingly short period the direct action of the steam; and, on the other, non-automatic apparatus allowing the direct working to be continued until the locomotive acquires its full speed, and giving besides a certain security against accidents always possible in running, as experience has shown. The advocates of the first claim that in the second there is a certain complication and the necessity of a special motion by the engineer, and moreover there is the possibility that the engineer may waste steam by continuing direct working longer than is necessary. On the other hand, it is said that automatic apparatus, apparently simple, become more and more complicated by the additions made to them in order to give them the necessary security, so that in the end they become much more complicated and give the engineer much more trouble than the necessity of making a simple movement of the lever, and that moreover they really deprive the engine of one of its most essential qualities. As to the fear of wasting steam, Mr. Urquhart says, "As to the possibility of a waste of steam by improper use of the starting valves, we are guaranteed against that by the premiums paid to engineers, which lead them to look to their own interests and not to use this valve more than is necessary." On the Southwest Russian Line, where no automatic apparatus is used, no trouble has ever been found in this way. It may be noted here that, although the economy obtained on these Russian lines is very considerable, it is not as great as it might be were they permitted to employ higher pressures.

REVERSING APPARATUS.

When the ratio between the volumes of the cylinders of a compound locomotive is comparatively low—that is, 1 : 2 or near that—it is necessary to give the two cylinders different admissions. The reasons are so well known that it is hardly necessary to repeat them here.

The first three locomotives on the Biarritz Railroad had a very high ratio—1 : 2.78—so that this question was not considered. On the following two, which had a much smaller ratio, a system was used permitting us to vary the cut-off separately on each cylinder, while leaving the two distributions joined to one reversing lever. This apparatus was also employed on the test engine of M. De Borodine and on several others, and also on Engine 701 of the Northern Railroad. The arrangement was modified by M. De Borodine on several engines in a very neat way by the use of a hollow screw inside of the large screw used for working the reversing lever, the screw containing a second one which commanded the admission of steam to the small cylinder. It is certain that the ability to give, under all conditions of working, the proper admissions to the two cylinders, permits us to secure not only the most economical results, but also the maximum power in compound working.

Fig 12.

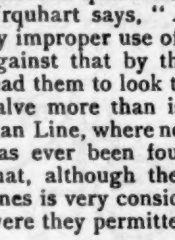


Fig. 14.

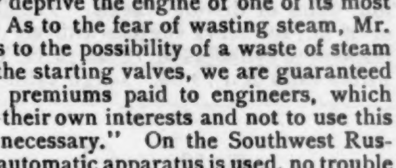
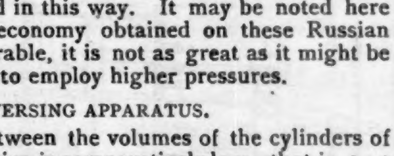
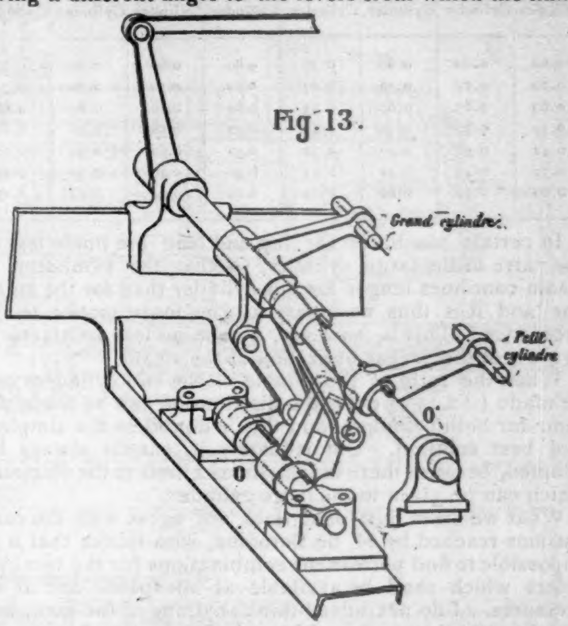


Fig. 15.



It is not less certain, however, that if the engineers do not follow to the letter the instructions which are given them and do not use exactly the proper cut-off, they will get a bad result. This objection was presented against my apparatus by M. Von Borries with some reason; he employed on his first small engines a similar arrangement, but has since used a system varying the admission of steam to the cylinders automatically. This consists in giving a different angle to the levers from which the links are suspended, as shown in fig. 12, or a different length to the link hangers. It will be seen that when the lever L is moved toward the right from the position shown in full lines to that shown in dotted lines, the lever 2 will move its link less quickly than the lever 1.

Fig. 13.



In forward motion the cut-off obtained for the two cylinders is as follows:

	Admission, per cent. of stroke.		
High-pressure cylinder	0.75	0.40	0.20
Low-pressure cylinder	0.75	0.50	0.33

The backward movement, however, is completely sacrificed. Sometimes this is not important, but this is not always the case, and it may be a very serious objection. I have obviated this by a differential arrangement, the principle of which is explained in figs. 14 and 15.

A shaft O carries a lever A, forming a link, the axis of which is at the extremity of a lever B, which is keyed upon the shaft o. If the system is moved between the extreme points represented in fig. 15 it will be seen that the angular displacements of the lever A are less rapid than those of the lever B. If then o is the reversing shaft and the link of the small cylinder is suspended from the lever B, and that of the large cylinder from the lever A, we would have a longer admission to the large cylinder than to the small, as in the Von Borries arrangement; but the points will be the same for both and the proportion of the admissions the same whether working backward or forward. Generally the arrangement has been to place the hanger of the link for the large cylinder on the main shaft and to connect it with the auxiliary shaft by a system of levers, as shown in fig. 13. The link of the large cylinder is then suspended from a lever loose upon the reversing shaft and worked by a differential movement. This arrangement, which is shown in fig. 13, was first applied to Engine 102 of the Swiss Western Railroad and succeeded perfectly. It is also used in Austria and on the compound engine of the French State Railroads which was at the Exposition of 1889. It was recently applied by Herschel & Sons, at Cassel, to compound engines built for the Prussian State Railroad.

To appreciate the better result from this arrangement over that by suspension from levers placed at different

angles, the following table is reproduced from a German paper, giving the relative admissions to the two cylinders in the two cases and in both directions. The distribution was made by a straight link and an Allan valve.

First Suspension.				Improved Suspension.			
Forward Motion.		Backward Motion.		Forward Motion.		Backward Motion.	
H. P. Cylinder.	L. P. Cylinder.	H. P. Cylinder.	L. P. Cylinder.	H. P. Cylinder.	L. P. Cylinder.	H. P. Cylinder.	L. P. Cylinder.
0.80	0.82	0.80	0.78	0.80	0.80	0.80	0.80
0.70	0.74	0.70	0.67	0.70	0.70	0.70	0.75
0.60	0.65	0.60	0.55	0.60	0.66	0.60	0.68
0.50	0.59	0.50	0.43	0.50	0.58	0.50	0.60
0.42	0.51	0.40	0.32	0.40	0.50	0.40	0.50
0.31	0.43	0.31	0.21	0.30	0.40	0.30	0.34
0.20	0.32	0.20	0.12	0.20	0.24	0.20	0.27

In certain machines the lap and lead are made less in the valve of the large cylinder, so that the admission of steam continues longer for this cylinder than for the small one, and it is thus necessary to give more motion to the eccentrics. This is, however, a solution less satisfactory, in view of the proper utilization of the steam.

When the ratio of the volume of the two cylinders can be made 1 : 2.25 or over, the distribution can be made the same for both cylinders, and this is doubtless the simplest and best solution. Unfortunately it cannot always be adopted, because there is sometimes a limit to the diameter which can be given to the large cylinder.

What we have just said does not agree with the conclusions reached by M. de Borodine, who thinks that it is impossible to find permanent combinations for the two cylinders which shall be available at all speeds and at all pressures. I do not indeed think anything of the kind, but that we ought to seek at the same time to avoid too great an inequality of work in the two cylinders and too great a fall of pressure between them, and any arrangement which will secure this double condition within practical limits and automatically should be preferred to a disposition which is more perfect in theory, but leaves more to the action of the engineer.

The only detail which we have still to consider is the intermediate reservoir. This is generally formed by the steam-pipe connecting the two cylinders, which is placed in the smoke-box and curved so as to follow its upper surface. This is the arrangement which was first employed in the Biarritz engines, and which has been everywhere copied. An exception is found in some of Von Borries' passenger engines, where the cylinders being placed considerably back of the smoke-box, were joined by a cylindrical reservoir under the boiler. In certain recent German engines also the connecting steam-pipe passes outside of the smoke-box. Finally, in the Saxon State Railroad engines, or at least in some of them, the steam-pipe forming the intermediate reservoir passes for a certain distance through the steam space of the boiler.

The heating of the intermediate reservoir is certainly useful, especially when it can be secured without cost by using the gases in the smoke-box, and not by taking it from the steam of the boiler, but it is not necessary to try to obtain this heating by long circuits, complicated and requiring numerous joints, because in that case more is lost by the resistance to the passage of the steam than is gained by heating it. This is confirmed by marine practice, where intermediate heating has been completely given up and engineers try to make the steam passages from one cylinder to another as short as possible. The best solution for locomotives is simply to cross the smoke-box when the position of the cylinders permits it, which is generally the case.

OBJECTIONS TO THE TWO-CYLINDER TYPE.

Before quitting the subject of compound locomotives of the two-cylinder type, it seems best to examine briefly two objections made especially to this type. I have said in 1877 that the only limit to its use was in the dimensions which it was possible to give the large cylinder. This limit was found much more distant than I thought at that time. We have been able to build compound engines of two cylinders of all the existing types having from one to

Fig 16

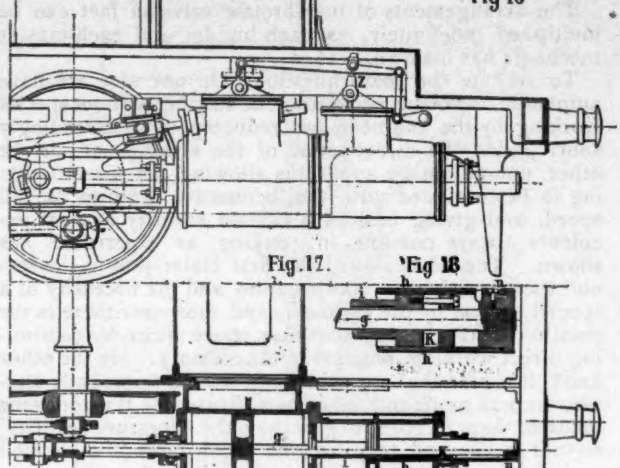
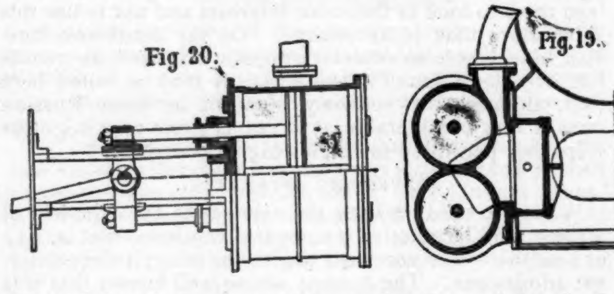


Fig. 17. Fig 18

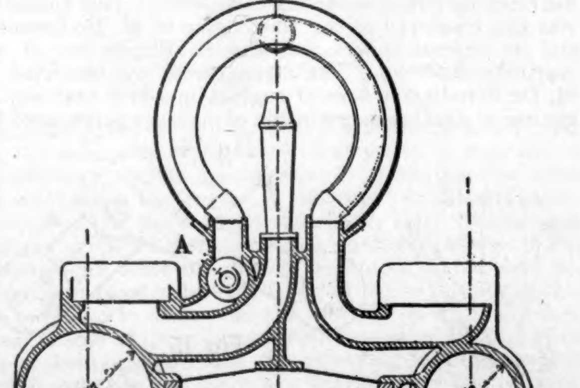
four pairs of driving-wheels. The large cylinders of 25 or 26 in., for heavy engines with six drivers coupled, correspond to cylinders of 17 or 18 in. of ordinary engines, with a ratio of 1 : 2.08. Large cylinders of 26 to 28 in.,

Fig. 20. Fig. 19.



giving ratios of about 1 : 2, are employed on eight-wheel coupled engines having ordinary cylinders of 18 to 20 in.; engines which have been built in considerable numbers for the Russian Railroads with a weight of 45 to 50 tons.

Fig 29.



Mr. Worsdell has been able to use between the frames an inside cylinder of 20 in. and one of 28 in. by inclining the axis of one cylinder in one direction and of the other cylinder in another, reducing, it is true, the ratio of volume to 1 : 1.96.

There was recently built in the United States by the Schenectady Locomotive Works a compound engine of which fig. 29 gives a cross-section, and of which the low-pressure cylinder has the large diameter of 29 in. We give here the principal dimensions of this engine, which has given most excellent results, and which seems to be a starting-point for the extended application of the principle of

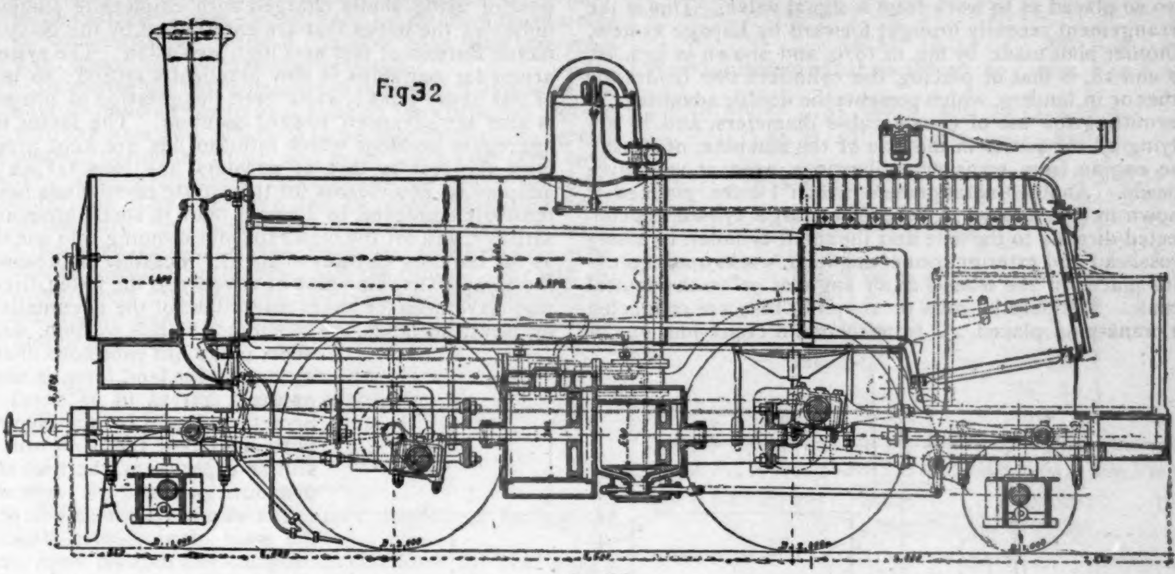


Fig 32

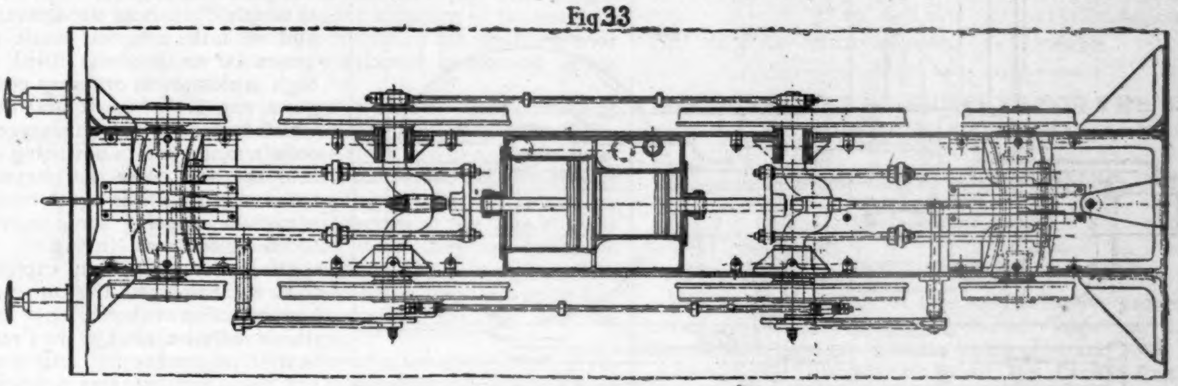


Fig 33

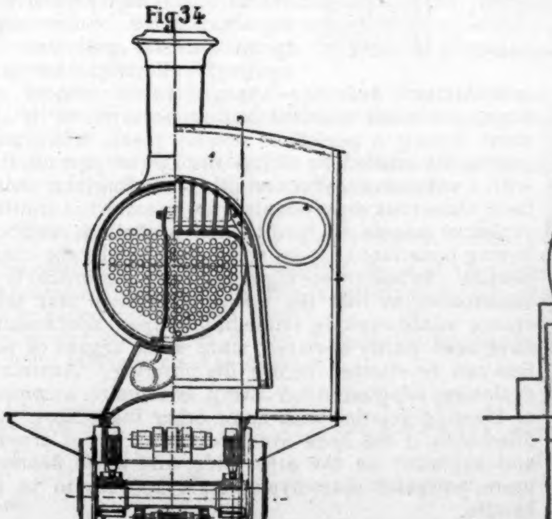


Fig 34

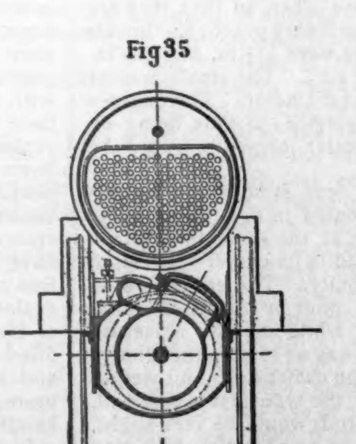


Fig 35

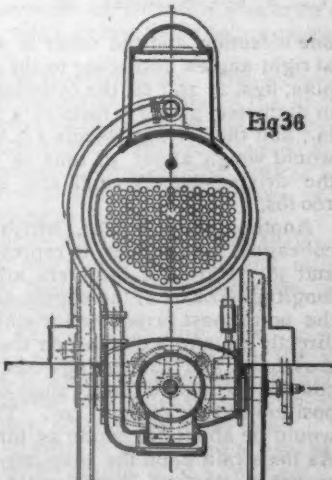


Fig 36

double expansion in America: Grate surface, 28.5 sq. ft.; heating surface (fire-box, 137; tubes, 1,540), 1,677 sq. ft.; working pressure, 180 lbs.; high-pressure cylinder, 20 × 24 in.; low-pressure cylinder, 29 × 24 in.; ratio of volumes, 1 : 2.1; diameter of drivers, 68 in.; weight on drivers, 97,000 lbs.; total weight, in working order, 126,800 lbs. This engine has six driving-wheels and a four-wheel truck.

This machine is provided with an automatic starting valve invented by Mr. Pitkin, placed at *A*. The same shops are now building several consolidation engines with the same arrangement and the same size of cylinders.

Generally the size of the cylinders is limited more by the position of the frames than any other cause, and therefore it is usually more easy to increase it in new engines than in old engines which have been changed.

Many ways have been considered of giving the large

cylinder sufficient size, not only to obtain the necessary power, but also to realize a ratio of volumes which will permit us, on the one hand, to simplify the distribution and, on the other, to utilize properly the higher pressures which the present tendency is to employ on railroads. I have suggested several years ago the plan, shown in figs. 19 and 20, of doubling the large cylinder and replacing it by two so placed as to work from a signal valve. This is the arrangement recently brought forward by Lapage as new. Another plan made by me in 1879, and shown in figs. 16, 17 and 18, is that of placing the cylinders one before the other or in tandem, which presents the double advantage of permitting the use of considerable diameters, and by applying all the power in the axis of the machine, of freeing the engine from transverse vibrations, even at very high speeds. Another arrangement which I have planned is shown in figs. 27 and 28, where the large cylinder is connected directly to the axle and the small cylinder, by a long crosshead and exterior connecting rods, works upon crank-pins placed in the wheels at an angle of 90° to the central crank. The parallel rods or coupling rods are connected to crank-pins placed 45° from the main crank-pin, one in

Fig 27

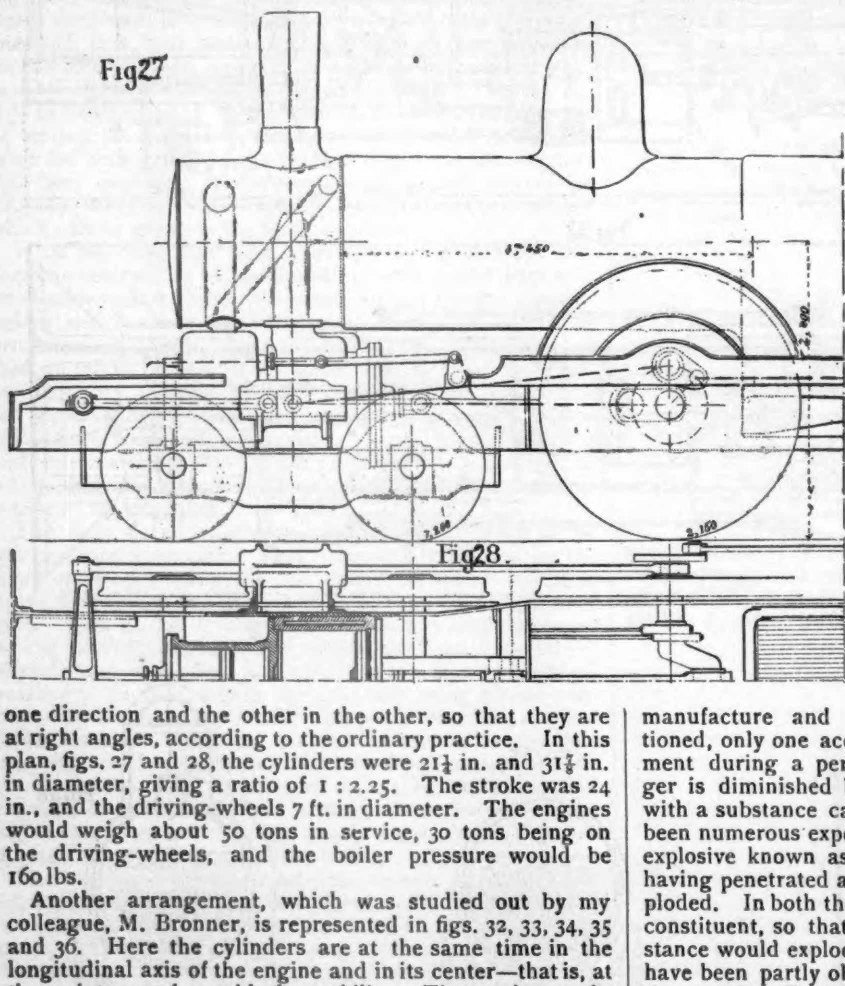


Fig 28.

one direction and the other in the other, so that they are at right angles, according to the ordinary practice. In this plan, figs. 27 and 28, the cylinders were $21\frac{1}{4}$ in. and $31\frac{7}{8}$ in. in diameter, giving a ratio of 1 : 2.25. The stroke was 24 in., and the driving-wheels 7 ft. in diameter. The engines would weigh about 50 tons in service, 30 tons being on the driving-wheels, and the boiler pressure would be 160 lbs.

Another arrangement, which was studied out by my colleague, M. Bronner, is represented in figs. 32, 33, 34, 35 and 36. Here the cylinders are at the same time in the longitudinal axis of the engine and in its center—that is, at the point most favorable for stability. The engine works directly on one axle, and on the other by means of a long crosshead and connecting-rods, while the two axles are coupled by outside rods in such a way as to keep the relative position of the cranks at 90°. The dimensions and weight would be about the same as for the type just mentioned. As the strain upon the coupling-rods would be very slight, except in starting, there would be no objection to giving them a considerable length.

The objection based upon the want of symmetry of the two-cylinder engine has disappeared by experience. It really never had much weight, and originated probably in a remark made by Mr. Webb, which was repeated by others, who did not understand its real purport.

(TO BE CONTINUED.)

HIGH EXPLOSIVES FOR MILITARY USE.

(From the New York *Times.*)

THE announcement that a special gun is under construction at the Washington Ordnance Yard for the purpose of using shells charged with emmensite sufficiently indicates the hopes that are entertained by the Navy Ordnance Bureau of this new high explosive. The system of armor for our ships is now practically settled ; so is that of our heavy guns ; while even the question of projectiles is also far advanced toward solution. The factor in the aggregate problem which hitherto has not kept progress with the rest is that of powders, and thus far we have adopted no equivalents for the nitrate compounds now extensively employed in Europe both in small arms and in artillery, and for the high explosives coming into use there, as the bursting charges of shells. Possibly one reason for the comparative slowness of advance in the latter direction may have been the hopes entertained of the pneumatic gun for naval purposes. The success of this weapon, with its short range but enormous charges, as mounted in land forts, is already assured, but as to its naval uses Secretary Tracy in his recent reports says that the *Vesuvius* "is still an experiment, the trial of her dynamite guns and the tactical test of the ship having been delayed by the want of projectiles, which the company has thus far been unable to supply." In these circumstances, and with the progress made elsewhere in using shells filled with high explosives in ordinary powder guns, capable of horizontal firing, which have a great advantage not only in range, but in not being built into the ship, like the pneumatic tubes, attention has again been directed to securing some such material for our own Navy.

Of the foreign high explosives thus far employed the one which has probably attracted most attention is mélinite, used by the French. In the 6-in. gun the projectile weighs 121 lbs., and contains a bursting charge of this high explosive weighing about 23 lbs. Such a shell used in an ordinary gun must be exceedingly effective. Its safety in manufacture and use appears to be almost unquestioned, only one accident having occurred in its employment during a period of several years, while any danger is diminished by filling the larger part of the shell with a substance called cresilite. In England there have been numerous experiments with a somewhat similar high explosive known as lyddite, and a shell is credited with having penetrated a 5-in. steel plate before the charge exploded. In both these high explosives picric acid is a chief constituent, so that the former objection that this substance would explode immediately upon concussion must have been partly obviated, since some degree of penetration can be effected before the bursting. Austria's high explosive, adopted in her army, is ecrasite, a composition of blasting gelatine with some other ingredient. A shell filled with it has been fired through 6 in. of armor plate and exploded on the other side, and while nearly a half more powerful than dynamite, it appears to be safe to handle.

Such examples, making full allowance for erroneous information, due to the secrecy with which experiments are invested, produce the conviction that the use of high explosives as the bursting charges of projectiles fired from ordinary guns is likely to be a feature of warfare in the near future. Emmensite, with which our Navy authorities are experimenting, is described by them as being composed of equal parts of nitrated carbolic acid, nitrate of soda,

and nitrate of ammonia. That it is far more powerful than gunpowder has been demonstrated. Like ecrasite it can be used in small-arm cartridges as well as in heavy shells, and when classed among the nearly smokeless powders is called gelbite, which is in the form of a thick yellow paper treated with emmensite. Its propulsive force is said to be as 14 to 5 compared with ordinary powder. The testimony as to its safety under concussion is decided, large cartridges of it having been hit by shots from a rifle without exploding, while it has also been fired through a 2-in. board and no explosion resulted.

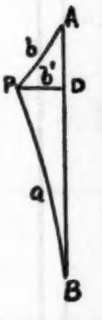
Of course the real possibilities of this high explosive can only be known after its final tests by the Ordnance Bureau with the new gun, which is to be shorter than the service piece of the same caliber, and more like a long rifled mortar. And while these experiments are going on in the Navy, the Army, through the Board on Magazine Small Arms, will be testing the Belgian Wetteren powder. Other high explosives and smokeless powders may enter into competition with these, and the coming year will see experiments with powders and magazine guns forming an interesting sequel to those of the present year with armor and projectiles.

A NOTE FOR SURVEYORS.

By Seth Pratt, C.E.

There is given below a new method of finding the azimuth of Polaris.

Most land surveyors lack the facilities for obtaining a meridian by the method of double altitudes of the sun or a star, and during portions of the year are unable to obtain the azimuth of Polaris by its elongations.



This *new method of finding the azimuth* at the instant that Polaris and any one of the bright circumpolar stars are in a perpendicular plane may be used when other methods are inconvenient or impossible. It consists in ranging out their direction at the time of their perpendicularity or when they are behind a plumb line, suspended with a weight. The data for this purpose being the star's polar distances and right ascensions, the date and the latitude of the place.

Let $A\ B\ P$ represent a spherical triangle revolving about the celestial pole of the earth, P the pole, A the place of Polaris, and B that of another star, and let the side $A\ B$ be supposed to be in a perpendicular plane, passing through the place of an observer in a given latitude.

The polar distances give the sides $A\ P$ and $B\ P$, and the *difference* of the right ascensions reduced to arc gives the angle $A\ P\ B$.

Subtract the right ascension of Polaris from that of the other star, borrowing 24 hours if necessary.

If the result be $\left\{\begin{matrix}\text{less}\\ \text{greater}\end{matrix}\right\}$ than 12 hours, the az. is $\left\{\begin{matrix}\text{E.}\\ \text{W.}\end{matrix}\right.$

The angle $A\ P\ B$ is *either* the difference of the right ascensions reduced to arc, or the supplement of 360°, *always* to be taken out less than 180°.

To find the angles A and B we have, by the first and second of Napier's Analogies,

$$\cos.\ \tfrac{1}{2}(a+b) : \cos.\ \tfrac{1}{2}(a-b) :: \cot.\ \tfrac{1}{2}P : \tan.\ \tfrac{1}{2}(A+B).$$
$$\sin.\ \tfrac{1}{2}(a+b) : \sin.\ \tfrac{1}{2}(a-b) :: \cot.\ \tfrac{1}{2}P : \tan.\ \tfrac{1}{2}(A-B).$$

Then will

$$\tfrac{1}{2}(A+B) + \tfrac{1}{2}(A-B) = \text{angle } A,$$

and

$$\tfrac{1}{2}(A+B) - \tfrac{1}{2}(A-B) = \text{angle } B.$$

Draw $P\ D$ perpendicular to $A\ B = b'$. Then, by Napier's rules for the *circular* parts, we have,

$\sin.\ b' = \dfrac{\sin.\ A.\ \sin.\ b}{R} = \dfrac{\sin.\ a,\ \sin.\ B}{R}$, and $\cos.\ \text{lat.} : R :: \sin.\ b' : \sin.\ \text{azimuth}$; or, reducing these two proportions to an equation, $\sin.\ \text{azimuth} = \dfrac{\sin.\ A,\ \sin.\ b}{\cos.\ \text{lat.}} = \dfrac{\sin.\ a,\ \sin.\ b}{\cos.\ \text{lat.}}$ (check).

Example: Required the azimuth of Polaris and Gamma, February 1, 1891, in lat. N. 40° 42'. 5.

Gamma, $R.\ A. =$ $0^h\ 50^m\ 6.^s62$ $P.$ dist. $= 29°\ 52'.046 = a.$
Polaris, $R.\ A. =$ $1^h\ 18^m\ 54.^s51$ $P.\ D. = 1°\ 16'.337 = b.$
$23^h\ 31^m\ 12.^s11$ $\sin.\ a = 9.697225$
P=supplement of $24^h = 28^m\ 47.^s89$ $\sin.\ b = 8.346427$
$\tfrac{1}{2}P$ in arc $= 3°\ 35'.98625$ cot. $= 11.201276.$
Lat. N. 40° 42'.5 cos. $= 9.879692.$

$\tfrac{1}{2}(a+b) = 15°\ 34'.019 \left\{\begin{matrix}\cos. = 9.983734\\ \sin. = 9.428726\end{matrix}\right.$

$\tfrac{1}{2}(a-b) = 14°\ 17'.854 \left\{\begin{matrix}\cos. = 9.986336\\ \sin. = 9.392419\end{matrix}\right.$

cos. $\tfrac{1}{2}(a+b)$ *a. c.*	.016266
cos. $\tfrac{1}{2}(a-b)$......	9.986336
cot. $\tfrac{1}{2}P$............	11.201276
tan. $\tfrac{1}{2}(A+B) =$	11.203878
	86° 25'.3

sin. $\tfrac{1}{2}(a+b)$ *a.c.*	.571274		
sin. $\tfrac{1}{2}(a-b)$....	9.392419	sin. A=9.115182	sin. a=9.697225
cot. $\tfrac{1}{2}P$........	11.201276	sin. b=8.346427	sin. B=7.766120
tan. $\tfrac{1}{2}(A-B)$=	11.164969	17.461609	17.463345
	86° 5'.237	cos.lat. 9.879692......	9.879692
sum $= A =$	172° 30'.537	sin. $Az.$=7.581917(check)	7.583653
sup.	7° 29'.463	sin. = 9.115182	$Az.$=13'9"W.
diff. $= B =$	0° 20'.063	sin. = 7.766120.	

THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.

By A. Zdziarski, Engineer.

(*Concluded from page 59.*)

V.—THE SOUTH OUSSOURI RAILROAD.

While the building of this road is for the present postponed, in 1887 it was considered a very important line, and the surveys were made in the years 1887 and 1888.

The South Oussouri Railroad, the Pacific link of the Great Siberian Railroad, is intended to connect the Amour watershed with the Pacific, or more explicitly, the Oussouri, a tributary of the Amour, with the port of Vladivostok. The terminal point on the Oussouri was to be either Grafskaia or Bousse, since below those points there is no obstacle to navigation.

Surveys were made in two directions. One followed the western slope of the peninsula, traversing the valleys of the Otinovka and Lefou rivers, crossed the Oussouri and followed its valley to Grafskaia. The other passed through the middle of the peninsula, crossing the central divide, then followed the valley of the Dombikhe River, crossing the Oussouri and ending at Bousse.

The first of these lines—Vladivostok to Grafskaia—is the better line for traffic, more easy to build, and estimated cheaper by 13,000,000 roubles. It will, therefore, require a more complete description.

The whole length of the main line from the station Mouraviev-Amourski, near Vladivostok, to the station Grafskaia is 256 miles, to which must be added the branches or extensions to the harbor of Vladivostok and the port or landing on the Oussouri, making 261 miles in all.

The main line of 256 miles is considered a level section, and will have maximum grades of 0.8 per cent., and a minimum radius of curvature of 1,050 ft. The port extension or branch at Vladivostok will have grades of 2 per cent. and curves of 700 ft. radius.

The greatest distance between water stations was fixed at 18 miles, in order to permit the running of seven trains daily each way, but the estimated supply of rolling stock is for three daily trains only.

The average quantity of earthwork will be 38,000 cub. yds. per mile, of which about three-quarters is in embankment and one-quarter in cutting. On the port branch the earthwork will be about 100,000 cub. yds. per mile. There will be required retaining walls at several points, some of dry masonry and some in mortar masonry.

Two tunnels will be required, one 665 ft. long, on the 13th mile, the other 1,090 ft. long, on the 32d mile.

There will be a few arch culverts and a number of small bridges of 7 ft. span, of wood. The rest will be of iron and will be as follows: 66 bridges of spans from 14 to 56 ft.; 1 deck bridge, 70 ft. span; 4 through bridges, 70 ft. span; 1 through bridge, 84 ft. span; 3 of 105 ft.; 1 of 140 ft.; 3 of 175 ft.; 3 of 210 ft.; finally one bridge, over the Oussouri River, with 7 spans of 252 ft. each.

tanks will be placed at 20 points, 11 regular stations and 9 sidings. The supply is everywhere abundant, from rivers, ponds and springs. The tanks will be of 2,744 cub. ft. capacity and the general arrangements the same as on the other lines.

The station yards will be paved and fenced and the stations fully supplied with signals, switches, etc. There will be five Sellers turn-tables of 55 ft. diameter, seven smaller turn-tables, three weigh-bridges and 60 switch-houses.

The supply of rolling stock, for three daily trains, will be 29 six-wheeled, 32-ton locomotives; 20 eight-wheeled, 42-ton locomotives, making 49 locomotives in all; 47 passenger cars and 372 freight cars. Sufficient repair shops will be provided.

THE SOUTH OUSSOURI SECTION OF THE GREAT SIBERIAN RAILROAD.

The total amount of masonry required will be about 105,000 cub. yds., while for the superstructure 5,000 tons of iron will be needed.

The length of sidings will be 11 per cent. of the length of main line.

The rails will be of somewhat light type, 54 lbs. Russian (49 lbs. English) to the yard. There will be 2,400 ties to the mile and 2,300 cub. yds. of ballast. Ballast is very scarce along the line.

The road buildings will be all of wood; they will include 36 section-houses, 21 double and 96 single watchmen's houses.

There will be 12 stations: one first-class (terminal); two second-class; one third-class and eight fourth-class; besides these there will be nine sidings with water tanks.

There will be four engine-houses with 30 stalls. Water

The cost of the line, 261 miles, is estimated at 24,000,000 roubles, or 92,000 roubles per mile.

The second line explored, from Vladivostok to Bousse, through the center of the peninsula and by the valley of the Dombikhe, is much more expensive and difficult. On the first 30 miles it requires 17 tunnels of from 350 ft. to 10,000 ft. in length, and many viaducts, some as high as 250 ft.; its estimated cost is 37,000,000 roubles. Moreover, it will have grades of 2 per cent., and curves of 1,050 ft. radius.

The Oussouri country has a moderate climate, generally a fertile soil; the rivers are abundant, the forests are full of large trees, and there are valuable mineral deposits; so that the country is capable of great development and has a promising future. At present the population is small, and labor difficult to secure; for this reason the estimated

cost of the railroad is much higher than for a similar line in European Russia.

VI.—GENERAL SUMMARY.

The total distance from the present railroad terminus, at Tumen, on the Toura, in Western Siberia, to the port of Vladivostok, on the Pacific, by the line adopted, will be as follows:

	Miles.
Tumen to Tomsk, by steamboat on the Toura, Tobol, Irtish and Obi rivers	1,870
Tomsk to Sretensk, railroad	1,895
Sretensk to Grafskaia, steamboat on the Shilka, Amour and Oussouri rivers	1,590
Grafskaia to Vladivostok, railroad	261
Total	5,616

The line will at first be made up of 2,156 miles of railroad and 3,460 miles of river navigation; but, as before stated, there is little doubt that the distance from Tumen to Tomsk will be filled by a railroad line starting either from Tumen or Chelabinsk. This will considerably shorten the distance, and will leave only the 1,590 miles of steamboat navigation on the Amour, which is very much better and less interrupted by winter than on the Obi and its tributaries.

That the railroad will be of great service to the Government, and will assist very much in developing the country there can be no doubt. As the longest continuous line in the world, it merits the attention of engineers everywhere.

A NEW STEEL TIE.

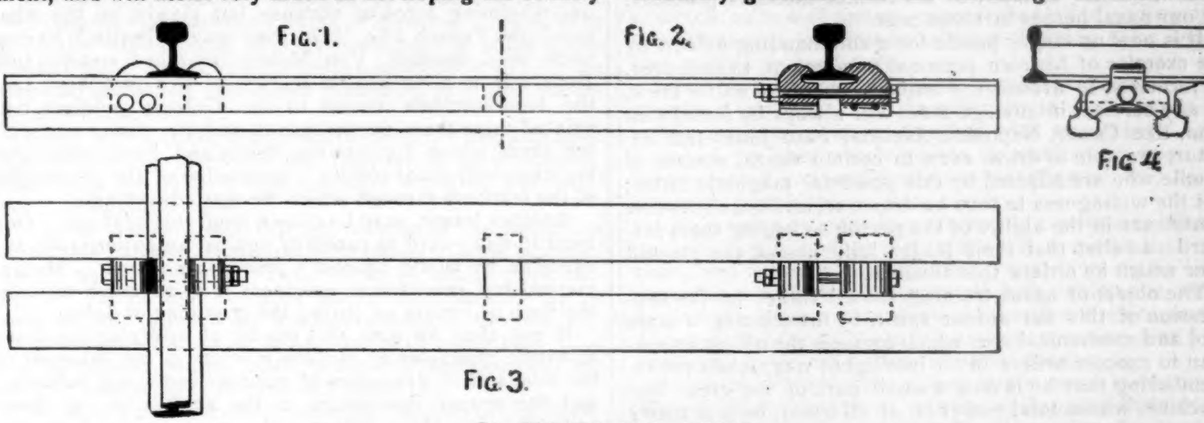
THE accompanying illustration shows a form of tie proposed by a correspondent, Mr. E. A. Cannon, of Minneapolis. Fig. 1 is a half elevation; fig. 2 a half cross-section; fig. 3 a plan, the rail being shown in place on one side, but removed on the other; fig 4 an end view. The advantages are named below. The sketch is given as a contribution to the solution of the tie question.

This plan is devised with the idea of utilizing material which all railroads have in plenty—old, worn-out rails. The description, with the illustration, will, it is believed, make the idea perfectly plain.

Material used to be old rails cut the required length, and four bolts, or two bolts and four rivets; more bolts can be used, if deemed necessary. Two pieces of rail are used for each tie, with the castings between them fastened together with screw-bolts or rivets. When in position the rail will be bottom side up, giving a broader bearing surface, and because the heads of old rails are usually very uneven. The *outside* casting on each side is intended to be stationary, fastened with bolts or rivets passing through it and the pieces of rail. The inside casting on each side is movable, so that the rail can be put in place easily. It is then drawn up and held in place by a screw-bolt, as shown; or a key can be used, if it is preferred or considered necessary.

Another casting or packing piece may be needed in the center, and one is shown in the drawing; this seems hardly necessary, but if desired it can be put in, as shown, at small cost, and will certainly give additional bearing.

Two rivets are shown in the drawing at each end, but probably one would be enough, or a bolt may be used instead, as noted above. The tie would give plenty of bearing in the ballast and a broad surface for the rail. Probably the most convenient length would be 7ft. 6 in.; that is, a 30-ft. old rail would cut into four pieces, making two ties.



[A TIE OF OLD RAILS.

OUR NAVY IN TIME OF PEACE.

By LIEUTENANT HENRY H. BARROLL, U. S. N.

(Continued from page 67.)

THE WAR COLLEGE AND TORPEDO STATION.

THE Naval War College and the Torpedo School are located at Newport, R. I. They were formerly two separate institutions, but in 1889 were combined under one management. The Station is under the direction of the Bureau of Ordnance.

These may be considered as post-graduate courses for those who have completed the term of study at the Naval Academy, although in some cases years elapse before the Academy graduate has the advantage of these latter courses. The War College, as its name implies, is for the purpose of imparting a closer knowledge of the art of warfare.

The painter or sculptor requires not only long practice before accurately posed models, but also close study of the finest works of other celebrated artists, before being able himself to picture the dew upon a rose leaf or to chisel from cold marble the life-like features of a Greek slave.

The art of warfare, likewise, requires that nothing be neglected, no pathway be left unexplored which may bring to light the best qualities of officers and seamen. All other sciences have in late years developed themselves into numerous specialties, to meet the requirements of the greater minuteness to which each branch of that profession has attained; and in like manner, among those who have made it a close study, naval warfare produces specialists in each of its several lines of duty.

Among the specialties to which modern warfare has given birth, and the details of which cannot be mastered by each individual officer, may be mentioned:

1. The more perfect designing of vessels, with finer lines, greater speed, a more complete angle of fire, a more compact arrangement of internal compartments, engines, coal-space, magazines, etc., whereby the greatest benefit is obtained from the allowed displacement.

2. Electrical engineering—invention, manufacture and use of torpedoes; the use of electricity for lighting ships; for guiding and exploding torpedoes; for search lights, to guard against torpedoes; for finding the range of the enemy; for signalling; for working and firing machine guns.

3. Attack by ramming or by torpedoes, and defense

against the same; tactical diameter of vessels and the maneuvering under different conditions, either to crush a hostile vessel or to avoid her deadly prow; the rigging of torpedo gear, wire nettings, booms, etc., to protect a vessel, and the various methods of destroying such protection of the enemy.

4. Invention and manufacture of high-powered steel, rifled cannon; rapid-fire guns; top-defense, or the defense by machine guns, mounted in steel-clad tops, supported upon military masts, against a possible attack of the vessel by torpedo boats; the manufacture of the highest grades of steel; inclined and vertical armor, and steel-faced projectiles for piercing the same, etc.

5. A higher system of navigation than that employed in former times; a more complete mastery of the magnetic compass, to compensate for the greater masses of metal used in the construction of modern vessels and guns; the determination of geographical positions by the use of the chronograph, and the electric cable.

6. A better organization for littoral expeditions; a more efficient landing organization, better armed and equipped, having a more complete knowledge of light-artillery practice ashore and the various forms of resistance there to be met.

These are some of the changes which have in late years been wrought in naval warfare, and with them comes a discontinuance of many of the former methods practised by our naval heroes in times past.

It is now no longer politic for a commanding officer, by the exercise of his own personal magnetism, to endeavor, as formerly, to arouse the enthusiasm of an entire crew. In any service, in any age there will always be found men who, like Cæsar, Napoleon, Nelson, Paul Jones and Decatur, are able to draw, even to certain death, masses of people who are affected by this powerful magnetic force; but the willingness to thus be drawn arises from a supreme confidence in the ability of the person so urging them forward—a belief that their leader fully knows the ground over which he orders this advance.

The object of naval training should rather be the suppression of this too ardent spirit, by introducing a more cool and mechanical one, which compels the officer or seaman to execute orders in an intelligent way, while yet remembering that he is only a small part of the great war machine, whose total power is, at all times, only properly known and correctly handled in the conning-tower.

In doing this, care must also be taken not to destroy the individuality of thought of the different persons, and thus train up a class of automatons. Men have been endowed by nature with powers of reason, and these must not be obliterated, but improved and intensified by education.

Officers and seamen should not only be allowed, but expected to reason; and a commander, no matter how small his command, be required to realize the responsibility placed upon him, even in the execution of an order. No manifestly erroneous or impossible order should be attempted. The fatal mistake made by Lord Cardigan, when at Balaklava he ordered the Charge of the Light Brigade, has been severely criticised by military men, and the execution of orders so manifestly erroneous would now possibly be attended with court-martial and dismissal.

While allowed to exercise his powers of reason, each individual need not necessarily be allowed to criticise or refuse to obey the rightful orders of a superior. He should be as oblivious as possible to all that surrounds him, except to those things which concern the execution of his immediate duty; to these he should be keenly alive, and should be ready to take the utmost advantage of every natural or mechanical means at his command to further its execution. To do this he should be as calm and collected as possible. Everything with him should be a matter of fact, which had long ago been reasoned out—not in the minds of others, but in his own mind.

There is a naval story to the effect that an ancient officer, finding fault with one of his juniors, remarked in thunder tones:

"Why did you do that, sir?"

"I thought—" began the trembling unfortunate.

"Blank-it-to-blank, sir! *You thought!* What business have *you* to *think! I am put here to think for you!*"

But in later years all of this has been changed, and commanding officers now avail themselves of the brains as well as of the muscular powers of their subordinates. Ignorance, carelessness or neglect of one's duty is no more condoned at present than in that day mentioned; but the ancient officer, if he were here, would now remark:

"Blank-it-to-blank, sir! *Why did you not think it well over, before doing* ANYTHING!"

In the day of sailing ships it was considered good practice for a young officer, as he stood the deck watch, to conjure up possible disasters which might befall the vessel, and having thus brought before his mind such an emergency, to reflect upon the line of action that should then be taken.

It has become an axiom in modern warfare, that all other things being equal, the cool and collected man, who is executing a carefully studied plan, will be successful over the enthusiast, who is acting under the impulse of the moment. As evidence of this, witness the termination of the Franco-Prussian war, as contrasted with that stubborn resistance met before Richmond, after four years of hard fighting.

There can be but one opinion as to the fact that the Confederates were less prepared to withstand the advance of the Federal forces than were the French to resist the German invasion; yet while Lee, Johnston and Longstreet, by their steady coolness, even under defeat, required that overwhelming force to advance but slowly, on the other hand, the French line, "On their way to Berlin," having once been checked, Von Moltke marched steadily into Paris. It is a noticeable feature of this campaign that the handkerchiefs issued to the German soldiers had printed upon them the fortresses and the routes connecting them which lay between Berlin and Paris; thus giving each individual soldier a knowledge of the geography of the territory through which he was advancing.

Another lesson may be drawn from this contrast. One must to-day guard as carefully against an enthusiastic advance as he would against a precipitate retreat. Mathematical and mechanical exactness is of as much value in the flush of victory as during the ignominy of defeat.

It can thus be seen that the art of *applying* the more scientific principles of modern warfare is not inherent in the minds of all graduates of military and naval schools; and the proper instructors in the application of these principles are those officers who have acquired special prominence in the different branches of naval duty.

The War College, therefore, can impart a class of information not otherwise obtainable except by experience in time of actual warfare—a method necessarily disastrous to the nation's forces. Experience in the use of the constantly improving engines of war has still to be dearly bought in absolute battle. There is no school for the naval fighter to equal that of the deck of a ship in action; and our estimates of the effect of machine guns, smokeless powder, balloon torpedoes, etc., must be largely a matter of conjecture, yet by instruction from specialists in each branch of naval duty, the errors occurring in actual conflict would be reduced to a minimum.

The system of instruction consists of lectures at which notes are taken and upon which recitations are afterward required. Various professional subjects are treated of in these lectures, extending from the organization of crews and the disciplining of men, to the handling of a vessel in action or the tactics of a fleet.

The adoption of the torpedo as an offensive and defensive weapon has radically changed naval warfare. The first attempts to use torpedoes were met by the declarations of prominent statesmen, that such a method of waging war was barbarous and contrary to the international rules existing between civilized nations; yet, notwithstanding the general objection to their use, they are now universally employed.

In America torpedoes were first used during the Revolution, when an effort was made to destroy the British vessels anchored in the Delaware River by the setting adrift of a number of kegs, filled with powder, and arranged to explode by clock-work.

As these drifted down they were seen by the English vessels, and were destroyed by the fire of cannon and

small-arms. Athough the attempt was not at all successful, it caused quite a commotion in the fleet; and the circumstance gave rise to a mock heroic poem, by Francis Hopkinson, entitled "The Battle of the Kegs."

During the war of 1812 stationary torpedoes, and also a submarine boat to carry torpedoes, were designed by Robert Fulton, but the systems, though elaborated, do not seem to have been of much advantage.

The first really successful use of torpedoes may be said to have been in 1854, when the Russians by this means defended the Baltic ports.

In our civil war, 1861-65, torpedoes were largely and effectively used in the defense of the Southern ports, and in many cases were the only deterring agents to the advance of our naval forces, until Farragut, at Mobile, showed that the danger to be apprehended from them had been greatly over-estimated.

The effectiveness of the torpedo has been greatly increased, and it has now become a weapon of the utmost importance. The rough kegs of powder used during the Revolution and the more systematized iron tanks designed by Fulton in 1812 bore little resemblance to the highly scientific machines which are to-day constructed. Nevertheless, Bushnell, of Connecticut, in 1778, conceived the system which to-day we find to be the most efficient—that of a submerged or partly submerged boat carrying an explosive charge.

The earliest torpedoes were placed to defend harbors, and consisted of stationary tanks of powder. These were generally exploded by contact fuses, having small glass vials of acids, which broke when the vessel collided with the torpedo, and acting upon other chemicals, produced the explosion of the charge.

These were equally dangerous to friend or foe, and after the declaration of peace the removal of these obstructions from the harbors was generally attended with difficulty and great danger.

During our civil war, for the defense of the entrances to certain harbors, torpedoes were arranged to be exploded by the electric current. These were generally quite successful, yet on one occasion one of our monitors lay for over an hour directly on the intersection of the two lines of bearing and over a large iron tank containing 2,000 lbs. of powder, which failed to explode, owing to the imperfect insulation of the current wires.

In later years movable torpedoes began to be used; first a simple can of powder, fixed upon a spar, projecting from the vessel's side, and thus carried into action, was by electricity exploded under or close alongside of the hostile vessel. These were soon succeeded by torpedoes which were attached by long lengths of wire rope to the vessel, and which by systems of steering apparatus could be veered alongside of the enemy, and there exploded either through electric currents, led along the wire rope, or by contact fuses borne in the torpedo itself. These were found to be less dangerous to the vessel which was exploding them than were the spar torpedoes, as the latter, being discharged at such close quarters, might, owing to the sudden carrying away of a guy-rope, etc., explode the charge under its own vessel.

The later and more perfect torpedoes, which are now propelled and guided by electricity, compressed air or other gases, or by some internally carried motive-power, are known as "Auto-mobile torpedoes," to distinguish them from those which are carried upon spars or propelled by current-wires reeled out and reeled in, at will, from shore stations; while stationary torpedoes are now generally alluded to as "submarine mines."

The defense against torpedo attack may be said to have almost kept pace with the improvement of the torpedo itself, and therefore, if our naval predecessors could now return, they would find themselves confronted with an entirely new method of attack and defense. Stationary torpedoes are now exploded by means of small counter-torpedoes, the discharge of which causes the explosion of the larger ones throughout a certain area. The invention of electric search-lights and machine guns have greatly reduced the time in which the torpedo officer has a chance to execute his delicate mission; while submarine torpedo boats and "fish torpedoes," as well as the greater speed lately attained, partly compensate to him for being under such strict surveillance and so rapid a fire.

It became manifest some years ago that the invention and manufacture of these more complicated machines required a school for their study, and the Torpedo School was established at Newport, R. I., for this purpose.

Each year a number of officers of different grades are ordered here to obtain a more thorough knowledge of the subject of torpedoes. The instruction embraces all things connected with the making of torpedoes, their care and their use. Certain days are set apart during the course for practical exercise in handling and exploding torpedoes at stationary or at moving targets.

As the course includes the manufacture of all that enters into the composition of the torpedo—the charge, the fuses which explode the same, and the motive, or guiding power, a review of chemistry is necessary, in order to enable one to keep pace with those discoveries which are constantly being made in that science.

The system of instruction is also that of lectures, and recitations upon the notes then taken, and is supplemented with practical exercises.

(TO BE CONTINUED.)

ON THE SOARING OF BIRDS.

WE republish below from *Nature* a fresh attempt at a solution of the mystery of the soaring of birds; some species of which, as is well known, possess the skill of gliding upon the air almost indefinitely without flapping their wings, and without losing height.

Such birds generally inhabit southern latitudes; they soar high in the air, and the difficulty in observing accurately their movements, together with our general ignorance of the laws which govern air resistances, have thus far prevented any satisfactory explanation of this deeply interesting problem.

The present attempt is scarcely more fortunate than its predecessors. The Author omits all numerical calculations, and assumes that the bird proceeds in zigzag lines, describing a series of figures of 8, in which the return against the wind is very much shorter than the course with or perpendicular to the wind, and he assumes also practically the same conditions for spiral soaring.

In point of fact, few if any birds soar in that way. They first acquire initial velocity by flapping their wings, and then lazily float in nearly full circles, drifting but little, while surveying the field for a meal. In this climate such birds (the hawks, the eagles, etc.) give once in a while a few strokes of the wing, occasional kicks, as it were, which seem utterly insufficient to maintain their speed, particularly when rising; but larger birds, further south, are said to start from a perch, and to soar for hours without a single perceptible movement of the wings.

Some birds of passage—the sand-hill crane, for instance—give us in the North an exhibition of their powers when they start on their southern migrations. They vault into the air and flap their wings slowly but vigorously, until they have gained an altitude of 1,000 to 1,200 ft. Then, stretching their rigid wings to the utmost, they wind up in a spiral 75 to 150 ft. in diameter, without another flap, to a height of one to three miles, and often beyond the limits of vision. When satisfied with the elevation gained, and with the condition of the wind at that elevation, the bird then heads due south, and transforms the height gained into horizontal progress by gliding downward in a straight line at such an angle as to produce the speed necessary to furnish a sustaining reaction and to overcome the head resistance. When this downward course brings him inconveniently near the earth, he rises again in a spiral, to repeat the operation.

Most observers are agreed that this manœuvre can only be performed in a wind blowing at the rate of 10 to 25 miles per hour. There may be a dead calm at the surface, but as experienced by æronauts and proved by the records on the Eiffel Tower, it frequently happens that not a breath stirs below, while a good breeze is blowing 1,000 ft. above.

Granting the wind, any explanation of the phenomenon in order to carry conviction should deal with numerical

examples, and give the data for a particular case. We should know:

1. The weight of the bird.
2. The area of surface, as well as the form of that surface, and its coefficient as compared with a flat plane.
3. The velocity of the bird.
4. The velocity of the wind.
5. The angle at which the bird obtains a sustaining reaction at the speed of soaring upward.
6. The additional angle, if any, required to produce the velocity when gliding south and downward.
7. The forward head resistance of the bird.
8. The rear resistance of the bird, or coefficient of impulse which the wind can impart.

Should any of our readers possess data or views on this subject, we shall take pleasure in publishing them.

The article above referred to, which is contributed to *Nature* by Magnus Blum, of Lund, Sweden, is as follows:

The interesting problem of the soaring of birds, though repeatedly discussed, especially in *Nature*, has not yet found a satisfactory solution. This is the explanation I propose.

Suppose that a bird soaring horizontally with a certain velocity enters a current of air cutting his own course rectangularly. The bird will be seized and partly borne by the wind. Instead of passing by calm the distance *a* to *b*, he will advance from *a* to *c* in the same space of time (see fig. 1; the arrow *e f* indicating the direction of the wind, and the cross-lines the length-axis of the wing-area). The way *a* to *c* evidently being longer than *a* to *b*, the bird, on arriving at *c*, has a greater absolute velocity than if he had pursued, in a calm, his course *a* to *b*. It is equally evident that, if the initial velocity of the bird and the velocity of the wind are properly adapted, the velocity of the bird at the point *c* can, in spite of the resistance of the air to his advancing, be greater than at *a*. If arriving at *c* the bird can turn against the wind * without considerable loss of velocity, it is clear that he is able to continue his new course for a short space, before his velocity sinks to the initial velocity which he possessed at the point *a*. During this part of his course, the relative velocity of the bird (with relation to the air) is more than twice the absolute velocity of the wind, supposing the initial velocity of the bird equal or superior to that of the wind. Let *d* be the point where the absolute velocity of the bird has sunk to the initial velocity. If the bird turns at *d*, so that his course crosses the direction of the wind at right angles, he is again ready to begin the same course as when starting from *a*. Thus, on the way *a* to *c* the absolute velocity increases, on *c* to *d* it diminishes as much.

Let us now suppose the direction of the wing-plane unchanged: the course of the bird will no longer lie in the horizontal plane, but, from reasons now easily understood, *a* to *c* will gradually drop down to the earth, according as the relative velocity diminishes; on the other hand, *c* to *d* will rise according to the increment of the relative velocity. Which will be the greater, the sinking or the rising, depends on several circumstances, but principally on the force of the wind, the adaptation of the wing-plane, the size and form of the bird, and the corresponding proportions between the bearing of the wings and the resistance of the air. This resistance is, of course, in proportion to the weight, less to the advancing of large birds than to the advancing of small birds. This is the reason why large and heavy birds are the best soarers.

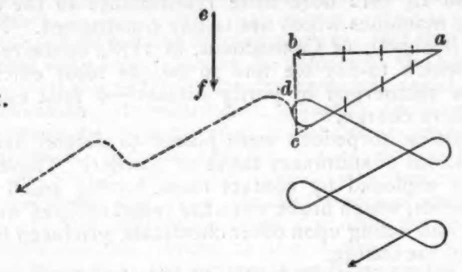
It results from this that a bird suitably built for the purpose cannot only maintain the same level without working his wings, by a uniform and moderate wind, but also gain in height by adroit movements.

It may perhaps be objected that, according to this scheme, the course of the bird will not be spiral, but run in figures of eights gradually moving in the direction of the wind or in continuous windings on the one or on the other side and partly with the wind (fig. 1). Indeed it is likely that the movements of the birds will often prove that they profit by this principle in manœuvres the purpose of which has not yet been understood.

* It has long been acknowledged that some birds possess the power of changing their direction without any sensible loss of velocity.

The spiral soaring is still to be explained. I think we must suppose that commodiousness is the principal motive thereof. Let us fancy that a bird, having acquired the necessary initial velocity, soars in a calm without working his wings, not in a rectilinear course, but by suitable inclinations and turnings of the wings in circular courses. We known that, in order to perform this manœuvre, the bird drops the interior wing a little and raises the exterior wing just as much, so that the wing-plane, during this motion, forms a conic ring, the top of the cone pointing downward. If the velocity did not diminish, the bird would be able to continue this course indefinitely, or he would rise or sink in a screw-formed course, according as the velocity should increase or diminish. By greater inclination of the wing-plane to the axis of the cone, the circles would become narrower; by diminishing inclination, they would become wider; both these motions are easily produced by minimal changes of the form of the wing-plane or of the place of the center of gravity. Let us further suppose that the stratum in which the bird soars is continually moving in a certain direction. From the

Fig. 1.



moment the course of the bird is perpendicular to the direction of the wind (point *a* in fig. 2) till the moment it grows parallel with it (*b*), the bird obtains from the wind an addition to his absolute velocity (not considering the loss occasioned by the resistance of the air) and also an increment of velocity from the moment his course deviates from the direction of the wind (*b*) till the moment it grows perpendicular to it (*c*). From this moment again the absolute velocity gradually diminishes, till, at last, at the point *f*, it reaches its minimum. From this point (*f*) a new circle begins identical with the first one, if the absolute velocity in *f* is the same as that in *a*, which does not

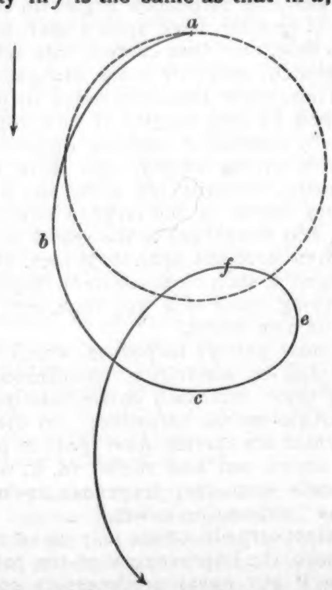


Fig. 2.

imply any impossibility, even including the resistance of the air to the advance. It is, however, important that the increment of velocity during the course *a b c* is equal to its diminution during the course *c e f*. Certainly the resistance of the air caused by the wind is greater during the latter part of the course than the former, but the distance during which it is working is shorter.

In which plane or planes the different parts of the course will pass depends upon the initial velocity and the changes

of relative velocity of the bird; naturally also upon the invariable quantities—the weight of the bird, the size and form of the wing-plane, so far as the latter has influence upon the resistance of the air to the advance. Now in *a* and *f* the relative velocity is the same as the absolute or minimal velocity. In *c* the relative velocity is also the same as the absolute velocity, but in *c* they are both greater than in *a* and *f*, as we have shown above. Thus the relative velocity has increased during the course *a b c*. From *a* to *b* no increment has occurred, but the contrary; so much the faster has it increased from *b* to *c*. During the course *c e* the relative velocity increases gradually, obtaining its maximum near *e*; whereas it gradually diminishes from *e* to *f*, so as to equal the initial velocity. Suppose, then, that the relative velocity diminishes somewhat during the course *a b*. This diminution, however, will be more than compensated for during the course *b c*, the relative velocity in *c* being greater than that in *a*.

During the whole course *c e f*, the relative velocity is greater than in *a* and *f*. Surely the supporting power of the current of air on the wings depends on the relative velocity. It increases with the relative velocity, if we suppose everything else to be unchanged, particularly the angle of the inclination of the wing-plane. If, therefore, the initial velocity in *a* by a certain pointing of the wing-plane is only just sufficient to maintain the bird at an unchanged level, the bird must, when describing the course *a* to *b*, gradually drop down. Even on the other side of *b* the sinking is continued until the relative velocity has increased so as to regain the same value as in *a*. From this point the course begins to rise and will continue rising until *f*, for to this point the relative velocity is greater than in *a*. Under such circumstances we cannot be astonished if the part *f* of the course will be in a higher plane than the part *a*, even if the resistance of the air to the advancing is infinitesimal.

Should the initial velocity in *a* be greater than what is required to maintain the bird on the same level, the bird would already have a rising course, and it might easily happen that no part of the course would be descending. However, the resistance of the air increases much faster than the relative velocity, and therefore the most available initial velocity will be different for different birds and for different force of wind. It is not as yet an easy matter to calculate the most favorable initial velocity to certain birds and to certain winds. But the discrepancies in the descriptions of the forms of the circles find, as may be easily seen, their explanations in supposing a different initial velocity. This is likely to be chosen differently by different birds, and may be different for the same bird according to different force of wind.

I am convinced that the bird always, even when soaring with the wind, has a greater velocity than the wind, and that thus during this part of the circle his speed is not hastened by the wind, but, on the contrary, he is here delayed, maybe less than in the other parts of the course. On the other hand, the velocity of the bird is augmented by the wind, as soon as the wind catches the bird from the side or obliquely from behind. This gain of velocity covers the loss caused by the resistance of the air to the advancing, and consequently allows the bird to maintain the necessary average velocity. It is less obvious, but nevertheless likely that the soaring bird, having gained the necessary velocity and having pointed his wing suitably, can without changing the form of his wings, incessantly continue the soaring as long as the force of the wind is unchanged.

Mr. Peal's explanation no doubt comes nearest the truth when he compares the soaring bird to a kite; we may consider the bird a kite, but the string which connects him with the earth is not fixed at a point of the surface of the earth, but the point of fastening moves with the wind, though it may be slower than the wind. It is the difference of velocity between the motion of the fastening-point and that of the air which affords the necessary power for the support and the rising of the bird.

Fig 1

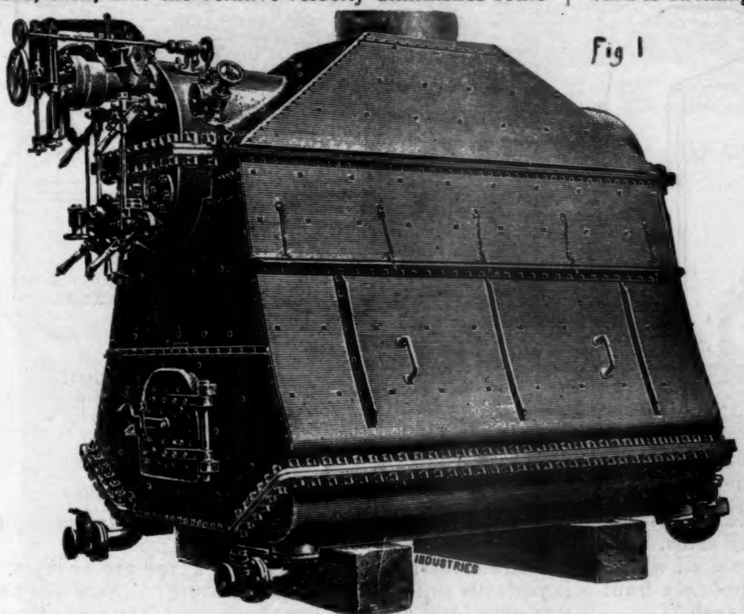
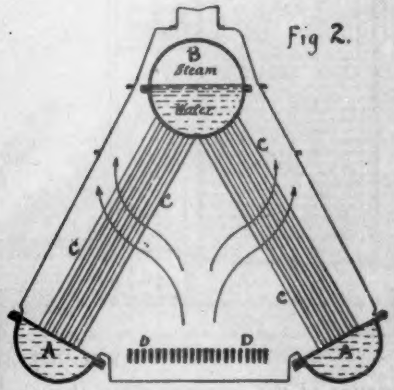


Fig 2.



THE YARROW TUBULOUS BOILER.

BOILERS FOR HIGH PRESSURES.

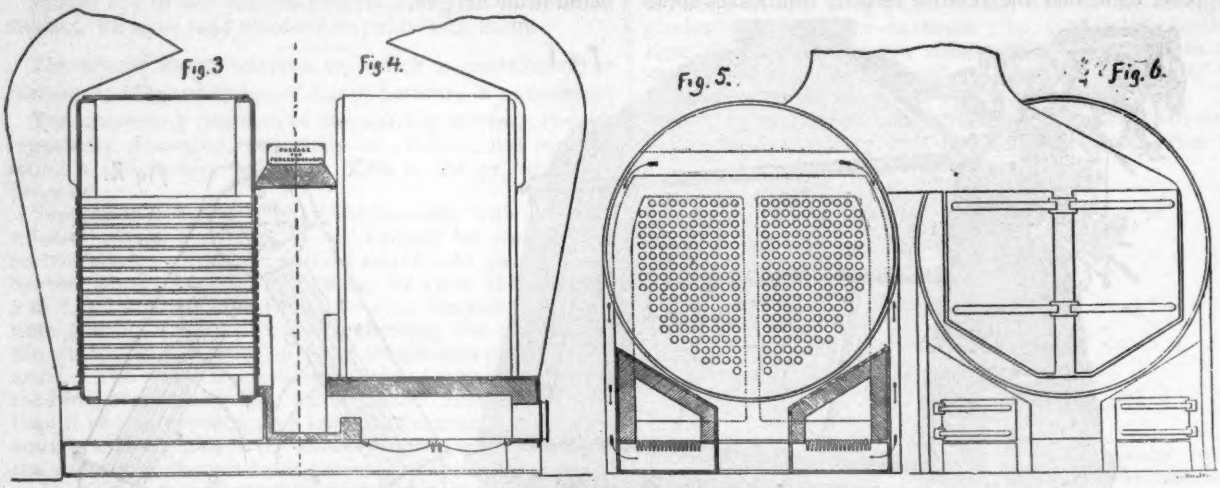
REFERENCE has been made in previous numbers of the JOURNAL* to the use of tubulous and other forms of boilers for producing steam of the high pressure which marine engineers are now disposed to use as most economical. In the accompanying engravings two forms will be found, one of which has been reduced to practice, while the other has only been suggested.

The first is shown in figs. 1 and 2, and is a boiler made by Yarrow & Company, Poplar, England, for a torpedo-boat recently built by them for the Argentine Republic. Fig. 1 is a general view and fig. 2 is a cross-section through the center.

The general construction of the new boiler will be clear from these engravings. Two parallel longitudinal chambers, *AA*, the cross-section of each having the form of a sector of a circle, are united with a third, *B*—of cylindrical shape—by a great number of steel tubes, *CC*. The section thus resembles an inverted V with the cylindrical chamber at the apex, the tubes sloping downward at an angle of about 30°. The two lower chambers form water-pockets, and the water extends up to about the middle of the top chamber, the remaining space of the latter being filled with steam. The flat surfaces of the water-pockets

* In the JOURNAL for July, 1890, page 319; for August, 1890, page 346; and for November, 1890, page 497.

form the tube-plates at one end of each series of tubes, the other ends being secured in the lower half of the cylindrical upper chamber. Each of the three chambers is about 6 ft. long, and the upper cylinder has a diameter of about 20 in.; each is made in two parts, with longitudinal flange joints. By removing the lower (circular) portions of the water-pockets *AA* and the upper part of the top cylinder *B* all the tubes are rendered accessible for cleaning or renewal. There is no direct connection between the lower chambers, and the whole system has complete freedom for expansion. The grate *D* occupies the space between the water-pockets, and the fire gases ascend between the tubes on either side, as indicated in the sketch, and over the top cylinder to the funnel. With the exception of the



PROPOSED HIGH-PRESSURE MARINE BOILER.

lower portion of the water-pockets, the whole is enclosed in a double wrought-iron casing filled with asbestos. All the tubes and chambers are of steel, and galvanized within and without. The feed-water is introduced from the front into the top cylinder near the middle of its length.

The circulation takes place upward through the hotter inner tubes—next the furnace—and downward through the outer tubes. Contrary to what might have been expected from the design, it is stated that no priming takes place.

Boilers of this kind have been in use for some time, and it is stated that no trouble has been experienced from leaking tube joints. As compared with a locomotive boiler suited for the same work, it is stated that the new generator is about 10 per cent. lighter, including coal and water. The cost is about the same in both cases.

The other boiler is shown in the second illustration, and is not of the tubulous type, but is a modification of the ordinary tubular marine boiler. In the engraving—for which we are indebted to *Industries*—fig. 3 is a section through the boiler; fig. 4 a section through the furnace; fig. 5 a transverse section and fig. 6 an end elevation. This form of boiler was recently suggested in a paper read before the Northeast Coast Institute of Shipbuilders & Engineers at Newcastle, England, and can best be described by a condensation of the paper.

To sum up his argument very briefly, the writer has endeavored to show that the economy of the three-crank triple-expansion over the two-crank compound has been mainly due to the increase of boiler pressure, and, to a small extent, to the increase of piston speed. That by increasing the boiler pressure to 250 lbs. per square inch a steam economy of, say, 15 per cent. can be obtained over the present three-crank triple. That an increase of piston speed, besides increasing the economy of steam, will also increase the weight economy, so that the piston speed should be increased up to the practicable limit. That the best type of engine to use this higher pressure, and best adapted to run at a high speed, is the four-crank four-cylinder engine, with unjacketed cylinders and separate steam and exhaust valves.

Passing on to the question of the type of boiler to be adopted, the writer is of opinion that a considerable departure from the present design of boiler is necessary, in order to make a satisfactory structure for 250 lbs. pressure. With this pressure difficulties will arise with the furnaces and the flat sides of the combustion chambers. To get over these difficulties the writer proposes to put the furnaces and combustion chambers outside the boiler altogether. The boiler then becomes a simple cylinder, the tubes running from end to end. As shown in figs. 3, 4, 5 and 6, the boilers are arranged back to back, with the combustion chambers between them. The furnaces and combustion chamber may be of cast or wrought iron, lined with firebrick. In order to keep down the grate surface, and thus economize space athwartships, it will be of advantage to use forced draft, and all the air on its way to the furnaces is made to pass over the top and sides of the combustion chamber, thus reducing to a minimum any loss from radiation.

The advantages of a boiler of this type are obvious. It is perfectly suitable for a high pressure. There will be no straining from unequal temperatures. The cost of manufacture will be considerably less than that of the present type of boiler. For the same heating surface the space occupied is less; the boiler shown in figs. 3, 4, 5 and 6 is 10 ft. 6 in. diameter, and contains the same heating surface as a boiler of the present type, 13 ft. 6 in. diameter, the lengths in both cases being the same.

A PARISIAN SUBWAY.

(From *Le Genie Civil.*)

THE Sceaux Railroad, built about 1848 on the plans of the Engineer Arnoux, was intended to show the possibility of using curves of very small radius. The principle of the system adopted consisted in the use of guiding rollers or wheels to keep the engines on the track, while the driving-wheels had no flanges.* Unfortunately this system was somewhat complicated for ordinary use and required a very wide guage, so that it did not come into general use.

The Orleans Company recently bought this short road, and is now rebuilding it as an ordinary road and supplying it with equipment of the ordinary types. In connection with this rebuilding the road is being extended from the old terminus for some distance into the city. The new terminus is at the Rue Medicis, and the underground line by which that point is reached is to be extended across the city to the Orleans station on the Quai Maubert. The extension from the Rue Medicis is being surveyed. With a short addition outside of the city this will make a very convenient loop.

The extension now building is entirely underground. With the exception of a short distance under private property it runs under the street, most of the way under the Boulevard St. Michel. The line is double track, and for most of the distance has a grade of 2 per cent. Where it is sufficiently below the surface the tunnel is arched over with masonry; at other points there are retaining walls

* This system was described and illustrated in the JOURNAL for January last, page 46.

supporting iron girders which carry the street pavement. The latter is the method shown in the accompanying illustration, which is a section through the station at the Rue Medicis, the arrangement of which is very plainly shown. At this point the track is 32.8 ft. below the street level.

Ventilation of this subway is provided for by iron shafts or chimneys placed in the center of the boulevard at intervals of 328 ft. Some of these shafts are shown in the cut; in a narrow or crowded street they would have to be differently placed. The station, it will be seen, has stairways leading to a passage under the sidewalk, the ticket-office and waiting room being in one of the buildings adjoining, so that there is no interference with the street itself. This subway has some points worth consideration here.

SUBWAY FOR THE SCEAUX RAILROAD IN PARIS.

THE UNITED STATES NAVY.

THE accompanying illustrations, from the report of Chief Constructor T. D. Wilson, show two important ships now under construction for the Navy, about which very little has been said thus far.

THE ARMORED CRUISER.

Armored Cruiser No. 2—the *Maine* is No. 1—which is under construction by the Cramp Company, in Philadelphia, and which will be named *New York*, will be a formidable vessel on account of her speed, her heavy battery and her powers of resistance. This ship will be 380 ft. 6½ in. in length on water line, 64 ft. beam, and will have a displacement of 8,150 tons, and a mean draft of 23 ft. 3½ in.

The main battery will consist of six 8-in. breech-loading rifles and twelve 4-in. rapid-fire guns; the secondary battery of 12 smaller rapid-fire guns, four 37-mm. (1.46-in.) revolving canon, and four machine guns.

The hull is to be protected by a vertical armor-belt over the machinery space, and by a steel protective deck from 2½ to 6 in. thick, extending from stem to stern. Within the armor-belt and above the protective deck a coffer-dam 3½ ft. wide is to extend the whole length of the ship, and to be filled with some water-excluding material.

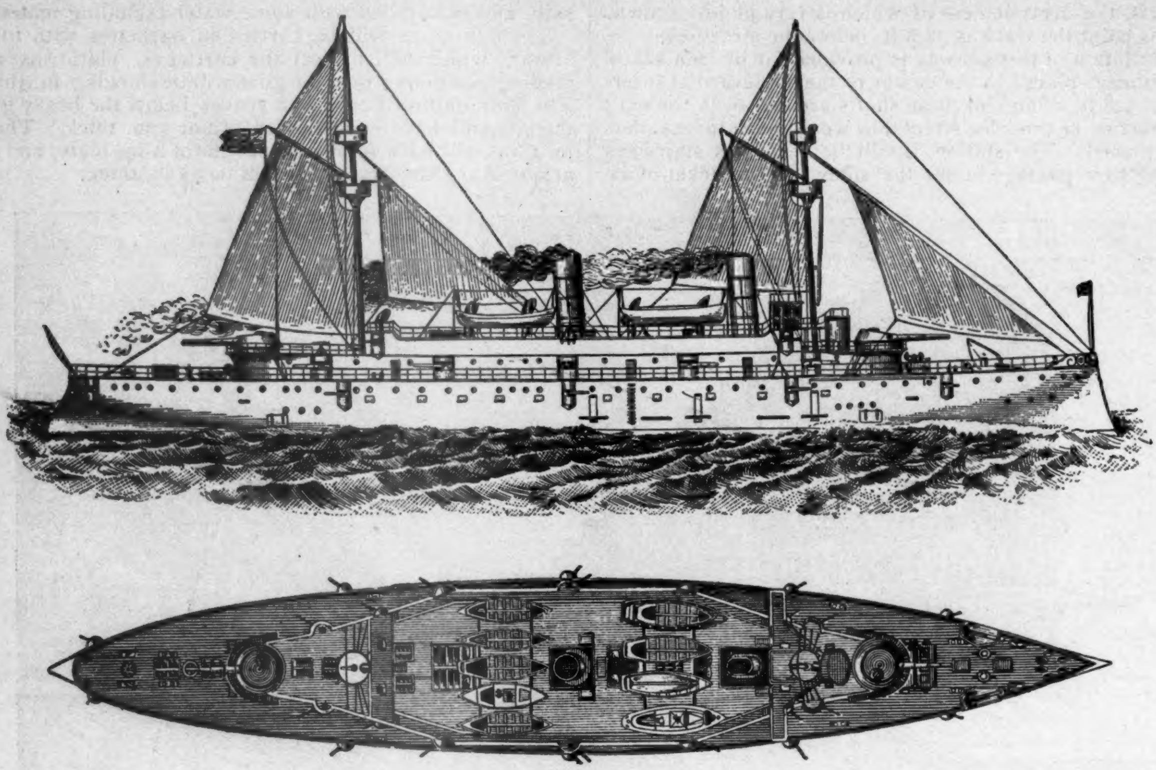
The 8-in. guns will be carried in barbettes with 10-in. armor, which will protect the carriages, platforms and loading positions; over the guns will be shields 7 in. thick. The ammunition hoists and spaces below the heavy gun-mounts will have cone-shaped armor 5 in. thick. The 4-in. guns will have segmental shields of 4-in. plate, and the armor of the conning-tower will be 7½ in. thick.

This ship will have twin screws and will have four engines, two on each shaft, so arranged that the forward engines can be uncoupled and only the after engines used when cruising at slow speed. The engines will be of the vertical, inverted cylinder, direct-acting, triple-expansion type, the cylinders being 32 in., 46 in. and 70 in. in diameter, with 42-in. stroke. The valves will be all piston valves, driven by link motions. The bedplates will be of cast steel, and the engine framing will consist of cast steel inverted Y-frames, two to each cylinder. There will be one condenser and one auxiliary condenser to each engine, and the circulating and air pumps will be worked by independent engines.

Steam will be furnished by six double-ended boilers, of the horizontal return fire-tube type, each 15 ft. 3 in. in diameter and 21 ft. 3 in. long, and each having eight corrugated furnace flues 3 ft. 3 in. inside diameter. There will be also two single-ended auxiliary boilers, each 10 ft. in diameter and 8 ft. 6 in. long, and each having two corrugated furnaces 2 ft. 9 in. inside diameters. All the boilers will be built for 160 lbs. working pressure.

For forced draft there will be six blowers—three to each fire-room—for the main boilers, and one blower to each auxiliary boiler.

It will be seen that this ship differs from all the other cruisers in having four engines, of which two will be sufficient for ordinary cruising, the others to be used only



CRUISER NO. 6 FOR THE UNITED STATES NAVY.

ARMORED CRUISER "NEW YORK," FOR THE UNITED STATES NAVY.

when high speed is required. These engines are expected to develop 16,000 H.P., and to propel the ship at a speed of 20 knots an hour.

The coal carried at normal displacement will be 500 tons; but the ship will be able to carry 1,500 tons altogether; this will give her a cruising endurance of 13,000 knots, at a speed of 10 knots an hour.

THE NEW CRUISER.

Protected Cruiser No. 6, which the Union Iron Works are now building in San Francisco, is a twin-screw protected cruiser, of the following dimensions: Length on load water line, 340 ft.; extreme breadth, 53 ft.; mean draft, 21 ft. 6 in.; displacement at normal draft, 5,500 tons.

This ship has a protective deck 4¾ in. thick on the slopes and 2 in. on the flat over the machinery space; 3 in. on the slopes and 2 in. on the flat forward and abaft of it.

A belt of water-excluding material 33 in. thick, in coffer-dams extending 4 ft. above and 4 ft. 5 in. below the load water line, extends the whole length of the vessel. Coal protection is afforded the machinery by the location of the bunkers along the side below the protective deck, and above that deck for the length of the engine and boiler space. The armored ammunition tubes are 3 in. thick, and the conning-tower 5 in. The hull plating is increased in thickness in the wake of all machine guns.

The main battery will consist of four 8-in. breech-loading rifles in barbette turrets 4 in. thick, and ten 5-in. rapid-fire guns protected by 4-in. segmental shields. The secondary battery will consist of fourteen 6-pounders, six 1-pounders and four Gatling guns. In each of the lower military tops will be mounted a 37-mm. Maxim gun and a 1-pounder Hotchkiss gun. The torpedo outfit will consist of six launching tubes for automobile torpedoes, one fixed at the stem, one at the stern, and two training tubes on each broadside.

There will be two vertical, direct-acting triple-expansion engines, one to each screw. The cylinders will be 42 in., 59 in. and 92 in. in diameter and 42-in. stroke.

Steam will be furnished by six boilers, two single-ended, each 15 ft. 3 in. in diameter and 10 ft. 11¼ in. long, with four corrugated tubular furnaces; the other four double-ended, 15 ft. 3 in. in diameter and 21 ft. 3 in. long, with light furnaces. They will carry 160 lbs. working pressure.

Working at full power and at about 128 revolutions per minute, the engines are expected to develop 13,500 H.P. and to give the ship a speed of 20½ knots an hour.

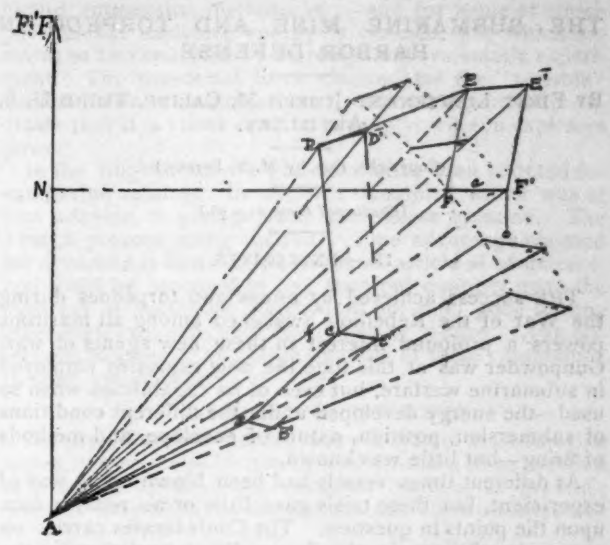
The full coal capacity will be 1,300 tons. At maximum speed this supply will give a steaming radius of 2,192 knots. At a speed of 10 knots it will give a cruising endurance of 13,000 knots, or about 54 days' steaming.

ANSWER TO A PROBLEM IN SURVEYING.

PROBLEM:* *To correct a random traverse of several courses between two known points.*

Let A, B, C, D, E, F represent a meander as originally run, of which A is the known point of beginning and F that of the terminus, and let A', B', C', D', E, F' represent a random as run from the same field notes and terminating at F'. It is required to determine the courses and distances of the corrections $B' B$, $C' C$, $D' D$, etc., to the true angular points of the meander as originally surveyed.

Measure the course and distance of $F' F$. Draw $A F'$, $A F$ and $A N$ and $O F'$ as meridians. From A as a center sweep arcs from F' and F to intersect radials drawn from A through the points B', C', D', etc. On each of



these radials form triangles equal to $A F' F$ and similarly situated, and draw $B' B$, $C' C$, etc., parallel to the sides opposite to A of the corresponding triangles.

These lines will represent the courses and distances of the corrections. From the field notes find the total latitudes and departures of the points B', C', D', E', F' and F. To determine the courses we have:

$$\text{Tangent of course} = \frac{\text{departure*}}{\text{latitude}}\;;\quad \text{distance} = \frac{\text{latitude}}{\text{cos.course.}}$$

From the similarity of the several triangles we have:

$$A F' : F' F :: \left\{ \begin{matrix} A B' \\ A C' \\ A D' \\ A E' \end{matrix} \right\} : \left\{ \begin{matrix} B' B \\ C' C \\ D' D \\ E' E \end{matrix} \right\} = \begin{matrix}\text{the corrections} \\ \text{in distance.}\end{matrix}$$

The angle $A F' F$ will be the *sum* or *difference* of $O F' F$ and $N A F'$.

Set the instrument over B', C', D' and E', direct the telescope toward A, and turn off an angle equal to $A F' F$ to the *right* or *left*, as the case requires, and measure off the proper distances.

Or, the courses may be determined by combining the angles $N A B'$, $N A C'$, etc., with $A F' F$. Making $A F'$ the meridian, the course of $F' F$ will be known, to which add or subtract $N A B'$, $N A C'$, etc., as the case requires. The sum or difference when less than 90° will be the course, otherwise its supplement.

No.	Example. Course.	Dist.	Lat. +N.	Lat. −S.	Dep. +E.	Dep. −W.	Total. Lat.	Total. Dep.		Course.	Dist.		Corrections. Course.	Corrections. Dist.	How Found.
		Ch.									Ch.			Lks.	AF′F=OF′F−NAF′ =S. 39°54′ W.
1	N. 62° E.	14.00	6.5726	......	12.3613	......	+ 6.5726	+12.3613	AB′	N. 62° E.	14.000	B′B	N. 78° 6′ W.	26.4	AF′F+NAB′=101°54′ Sup.=N. 78°6′ W.
2	N. 43½° E.	8.00	5.8030	......	5.5068	......	+12.3756	+17.8681	AC′	N. 55°18′ E.	21.735	C′C	N. 84°48′ W.	40.9	" +NAC′= 95°12′ " =N. 84°48′ W.
3	N. 5° W.	12.00	11.9543	......	......	1.0459	+24.3299	+16.8222	AD′	N. 34°40′ E.	29.579	D′D	S. 74°34′ W.	55.7	" +NAD′=........... S. 74°34′ W.
4	N. 72½° E.	10.25	3.0822	......	9.7756	.....	+27.4121	+26 5978	AE′	N. 44°8′ E.	38.195	E′E	S. 84°2′ W.	71.9	" +NAE′=...........S. 84°2′ W.
5	S. 12° W.	6.43	....	6.2895	....	1.3369	+21.1226	+25.2610	AF′	N. 50°6′ E.	32.928	F′F	West.	62.0	" +NAF′=........... West.
6	West.	.62	....	......	....	.62	+21.1226	+24.6410	AF	N. 49°24′ E.	32.455				

If it be desirable to re-run the meander from the corrected field notes as a test of accuracy, we have:

$N A F' \sim N A F =$ the correction in the courses and

$\dfrac{A F}{A F'} =$ the corrected length of the random chain.

* See JOURNAL for September, 1890, page 417; and for December, 1890, page 542. The problem was submitted by F. Hodgman, C.E., of Climax, Mich., and answered by him. The present answer is by Seth Pratt, C.E.

* The courses and distances are readily computed by logarithms. Thus, { log. tan. of course, = 10 + log. Dep. — log. Lat. / log. Distance, = 10 + log. Lat. — log. cos. of course.

With these corrections, the original meander may be re-run, and if the work be accurately done, the last course and distance will terminate at *F*.

THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page 78.*)

IX.—EXPLOSIVES.

The success achieved by mines and torpedoes during the War of the Rebellion awakened among all maritime powers a profound interest in these new agents of war. Gunpowder was at this time the only explosive employed in submarine warfare, but even of its capabilities when so used—the energy developed under the different conditions of submersion, position, nature of envelope, and methods of firing—but little was known.

At different times vessels had been blown up by way of experiment, but these trials gave little or no reliable data upon the points in question. The Confederates carried on some experiments in the James River to determine the amount of gunpowder charge, when placed as a ground mine upon river bottom, necessary to destroy a 1,000-ton vessel. From these experiments they deduced the general rule that in two fathoms of water 300 lbs. of gunpowder was required to destroy a vessel of this tonnage, which amount was gradually increased until in eight fathoms 2,400 lbs. was necessary. They further announced that where the bottom was rocky, 25 per cent. should be deducted from the amounts, and that one-third of these figures should be added for every 1,000 tons increase in a vessel's measurement.

To discover the laws governing subaqueous explosions was the problem presented to the engineer when the question of mine defense—of preparing and planting a system of mines—came to be solved. To this end a series of experiments were inaugurated in the United States soon after the close of the war. This was the most systematic and extended course of experiments ever undertaken in this country or, perhaps, in any other, to determine the laws governing the transmission of explosive energy through water, the explosive best adapted for submarine mining, together with all the attendant questions of mine-case, position, mooring, fuses, and manner of firing. It was carried out under the direction of General Abbott, in charge of the School of Submarine Mining, at Willet's Point, New York Harbor. Beginning in 1869, these experiments extended through the ten or twelve years following, and were so carefully made, and the details so minutely recorded, that the report upon the subject has become a classic.

In these experiments almost every kind of explosive then known was used—gunpowder of various grades, gun-cotton, nitro-glycerine, the dynamites, and explosive gelatine. The dynamometer used to measure the energy developed by these explosives was the crusher-gauge or pressure-piston, something after the kind employed in measuring the pressures in the powder chamber of a gun. The measure of the energy was the amount of compression of a small cylinder of lead placed under the base of a piston, the head of which, of given sectional area, was exposed to the action of the explosive charge. Two kinds of apparatus were employed in General Abbott's experiments—the one a stout ring of wrought iron, of diameters varying from 3 to 8 ft.; the other a crate of like material, 50 ft. × 10 ft. × 10 ft. In the center of each the charge of explosive was suspended, while the gauges, 6 in one case and 36 in the other, were rigidly secured in sockets about the circumference of the ring or at the angles of the crate; these were then suspended at different depths by suitable buoys, and the charge fired electrically.

Abroad the experiments have been largely made against targets representing approximately the shape and structural strength of the bottom of a war-ship, or against old hulls strengthened for the purpose, the gauges being secured against the side of the target or vessel.

From the data thus obtained formulas have been deduced into which all the conditions of the problem—strength of explosive, its distance, position, etc.—enter as factors. In the United States these have been obtained almost wholly from the pressure-gauge records, usually with small charges, while abroad, particularly in England, the actual destructive effect obtained with fairly large charges against a ship's bottom has been chiefly relied upon, the crusher-gauge records in these trials having never been published, and are supposed to be unreliable.

Of explosives in general, it may be said that they all belong to one of two classes—mechanical mixtures or chemical compounds. In the one case, as of gunpowder, the ingredients are mechanically mixed, and may be separated by mechanical means. The explosion is by the combustion of the individual grains. In the other class—represented by all the so-called high explosives—the composing elements are in chemical combination, and cannot be separated except through chemical change. Explosion is not by combustion; there is a simultaneous decomposition of the compound (detonation), and the initial pressure is the maximum one.

The introduction of the high explosives was an immense gain in the matter of submarine mining. This not only on account of the vastly greater explosive power they possess, but also from the fact that many of them are practically unaffected by the action of water. When the difficulty of excluding moisture from a submerged metal case is remembered, this latter gain will appear almost as great as the first.

Of the many kinds of high explosives employed in the experiments above referred to, but four or five have been found suitable for submarine work. These are gun-cotton, dynamite No. 1, explosive gelatine, blasting gelatine and forcite, or forcite gelatine. Of the others—dynamite Nos. 2 and 3, Hercules, Vulcan, and Atlas powders, tonite, etc.—the nitro-glycerine is mixed with the salts of sodium, potassium, magnesium or baryta, which are more or less deliquescent, and the compound is likely to deteriorate with exposure in a mine case.

The composition of these compounds is fairly well known. Dynamite No. 1, with its 75 per cent. of nitro-glycerine and 25 per cent. of absorbent earth, is usually taken as the standard in estimating the relative strength of various explosives. Explosive gelatine differs from blasting gelatine in the addition of a small amount of camphor. The constituents are of nitro-glycerine, nitro-cotton and camphor, 89; 7 and 4 per cent. respectively for the one, and of nitro-glycerine and nitro-cotton, 92, and 8 per cent. respectively for the other. Forcite gelatine, or forcite, has 95 per cent. nitro-glycerine and 5 per cent. unnitrated cellulose. The presence of the camphor in the explosive gelatine renders it practically insensible to shock. Under these conditions only a powerful primer will explode it. Rifle bullets fired into it at short range will not. It is believed to possess both mechanical and chemical stability, while its explosive power is greater than that of any other high explosive now in use.

As the result of General Abbott's experiments, he recommends that when it is necessary to use gunpowder for submarine mining only the finest grades should be used—sporting powder having 2½ times the strength of mortar powder when fired under water; that large charges are desirable; that strength of case is of great importance—a charge in a strong iron case giving three or four times the energy than if in a case of wood; that the nearer the case approaches a sphere in shape the better, and that an air space above the charge is advantageous in serving to direct the blast. He adds that, as regards the explosion of gunpowder, no great uniformity of results can be expected. These opinions are in the main concurred in by foreign engineers.

With regard to the high explosives he makes the following deductions: That only a moderate submergence is necessary to obtain the maximum force of explosion—a submersion of 4 ft. for a 100-lb. charge and 4 ft. per 100 lbs. additional for larger charges being sufficient to pro-

duce explosion of the first order; that a weak envelope gives better results than a strong one, and that with a proper quality of explosive no danger of deterioration after planting a mine need be apprehended, provided that the priming charge is kept dry by enclosing it in a separate envelope.

The following is given by General Abbott as the relative intensity of action, per unit of weight, of the various explosives when fired under water (dynamite No. 1 being taken as the standard):

Dynamite No. 1	100
Gun-cotton	87
Nitro-glycerine	81
Explosive gelatine	117
Gunpowder	20 to 50

English writers on the subject give a different explosive value to some of these compounds. Colonel Bucknill gives the following:

Dynamite No. 1	100
Gun-cotton, dry	100
Explosive gelatine	117
Forcite gelatine	133
Blasting gelatine	142
Gunpowder	25

From his experiments, General Abbott assumes that an instantaneous mean pressure of 6,500 lbs. per square inch will give a fatal blow to a modern iron-clad. Colonel Bucknill, on the other hand, believes this to be inadequate, and places the pressure per sq. in. necessary to destroy at 12,000 lbs.

General Abbott gives the following as the horizontal and vertical distances, in feet, at which the various explosives will destroy a modern iron clad, calculating 6,500 lbs. per sq. in. as necessary for this purpose:

	100 lbs.		500 lbs.	
	Hor.	Vert.	Hor.	Vert.
Dynamite No. 1	16.3	18.6	35.0	40.0
Gun-cotton	14.7	17.3	31.7	37.3
Explosive gelatine	18.2	20.3	39.1	43.7
Gunpowder (sporting)	3.3	3.3	19.5	19.5

Colonel Bucknell, from the *Oberon* and other experiments, gives the following as the charges and distances necessary to destroy a first-class war-ship with double bottom, assuming 12,000 lbs. per sq. in. pressure as being required:

Distance in Feet.	5	10	20	50
Explosive.	lbs.	lbs.	lbs.	lbs.
Blasting gelatine	23.5	75	177	465
Forcite "	25	80	188	496
Dynamite & Gun-cotton	33	107	251	660
Gunpowder	132	428	1,004	2,640

He also gives the following as showing the wide difference in results obtained in working out tables of destructive charges of blasting gelatine and dynamite, with General Abbott's formula and his own:

Distance in Feet.	5		10		20		40	
Explosive.	Gelatine.	Dynamite.	Gelatine.	Dynamite.	Gelatine.	Dynamite.	Gelatine.	Dynamite.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Abbott	4	7½	17	32	67	127	311	581
Bucknell	23½	33	75	107	177	251	369	525

It would not be safe to predict that the explosives above mentioned will hold the field indefinitely against the host of new compounds that have been brought forward for recognition during the last half dozen years—bellite, hellhoffite, emmensite, melinite, etc.—and for some of which phenomenal explosive energy is claimed, but which remains to be confirmed by thorough and systematic experiment. The wonderful force claimed for the "terrible" French melinite is remembered. Recent experiments indicate that it is about equal to nitro-glycerine in explosive power.

In the English service gun-cotton has been adopted for submarine mining. In our own dynamite, which was at first adopted, is giving place to explosive gelatine. The French propose using melinite. One advantage claimed for dynamite is that it has become an article of commerce, and could be procured in any required quantity upon the outbreak of hostilities, which does not hold good for any other high explosive used in submarine mining. The objections to keeping any large quantity of these compounds in store are evident.

X.—PLANTING THE MINES.

As preliminary to putting down a system of submarine mines, the points to be determined upon are as to the kind of mine to be employed—whether buoyant or ground; whether they shall be simple contact, electro-contact, or

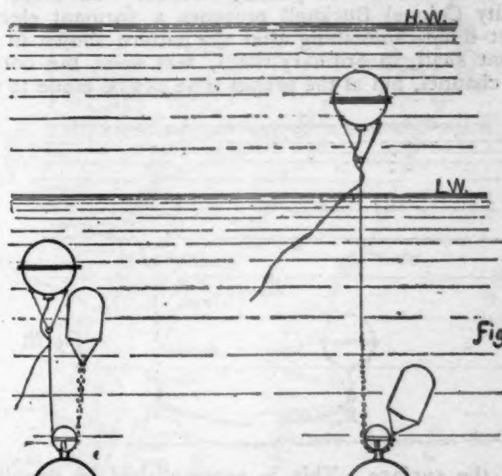


Fig. 17.

observation mines; whether anchored upon one or more lines, and the distance between the lines and the individual mines. As to the distance between the mines, the general rule that they shall be near enough together to make it impossible for a hostile vessel to cross the mine-field without coming within the destructive area of one or more of the mines, must be subordinated to the requirement that sufficient distance shall be maintained to prevent the destruction of adjoining mines by the explosion of one. A high explosive mine is much more liable to sympathetic explosion than one charged with gunpowder. Five hundred pound buoyant gunpowder mines may be anchored within 100 ft. of each other without danger from this cause, while those of blasting gelatine would require an interval of more than 400 ft.

After all the preliminary questions have been settled, the actual planting of a series of mines is by no means an easy task. The conditions to be satisfied are many and exacting. The more important of these conditions are that the individual mine shall maintain its position; that it shall remain at an effective depth at all stages of tide; that its explosion shall not endanger adjoining mines; that no entanglement of the cables of two or more mines shall be possible, and that it shall at all times preserve its invisibility. If the mines are to be fired by observation, the first of these conditions is of the greatest importance.

Where there is great rise and fall of tide the difficulty of maintaining a mine at a proper depth can well be understood. Anchored in the ordinary way, it would, at low water, either float upon the surface, or at high water be too deeply submerged to be effective. To overcome

this difficulty, Captain Ruck, of the Royal Engineers, has invented an ingenious method of mooring, as shown in fig. 17. To the mooring rope of the mine a length of chain is attached, whose links vary in size and weight. This passes through a pulley and is secured at the other end to a counterpoise of peculiar construction. As the tide rises the increased water-pressure upon the counterpoise reduces its buoyancy and the mine rises, pulling up the chain. As the tide falls, the weight of the chain and the increased buoyancy of the counterpoise pulls the mine down to its original position. The position of the mine is shown at high and low water.

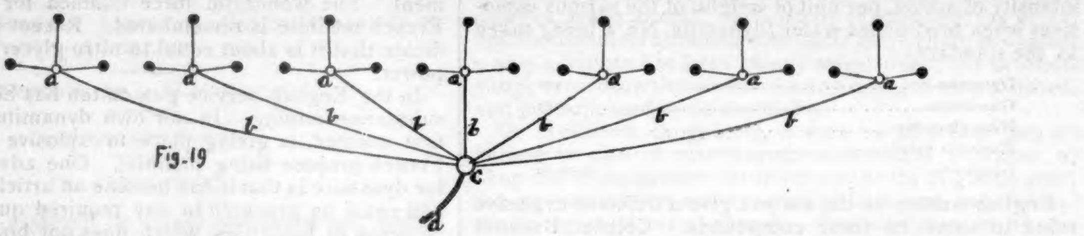


Fig. 19

In deep channels much used by friendly shipping it would be unadvisable to plant mines in advance of actual hostilities, unless some way were devised to protect them against constant collision with passing vessels. To meet this difficulty Colonel Bucknell proposes a dormant electro-contact mine—something after the pattern shown in fig. 18—that shall, in ordinary times, rest upon the bottom of the channel, but at the proper time can be made to rise toward the surface. This is accomplished by doubling down the mine rope and securing it near the mine case to its own or a second anchor, by an explosive link of brass or iron tubing, containing a small bursting charge and an electric fuse, which can be fired without disturbing the mine. When the link is exploded, the mine is released and rises to its proper position.

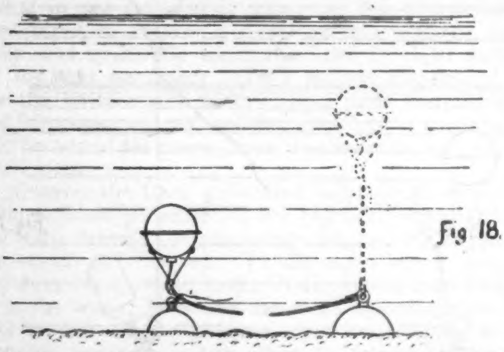


Fig. 18.

The size of mines to be employed and the manner of grouping vary with the different conditions of depth of water, width and character of the waterway to be defended. In our own service, where a considerable area is to be covered, the mines are arranged in grand groups of 21, subdivided into 7 groups of 3 each, as shown in fig. 19. This represents a system of electro-contact mines which may be fired at will or arranged to fire automatically upon contact. In the figure *a a a* are the triple junction-boxes; *b b b* single core cables; *c* the grand junction-box, and *d* the 7-cored cable leading to the firing station. As thus arranged, each core of the cable controls a group of three mines, and if fired from the shore station the group of three must be fired together. Any single mine may be discharged independently by contact with a passing vessel. The system might be so arranged as to have a separate wire for each mine, a triple cored cable connecting the group and the grand junction-boxes.

Junction Boxes.—These are water-tight boxes of cast iron, of any suitable shape, usually circular, as affording the greatest interior space, within which the connection between the mine wires and the multiple cable is made. They should be heavy enough to serve as their own anchor, be in some accessible place, but with no visible buoys to indicate their position to an enemy.

Disconnectors.—If a number of mines are connected up to the same main cable, and one of such a group be exploded, the bared end of the broken wire is likely to short circuit the main current, so that the others cannot be fired. To guard against this, a *disconnector*, or *cut-off*, is introduced into the circuit between each mine and the main cable, so arranged that upon the explosion of any one mine it shall be cut out from the main circuit. These are of a number of different patterns, the idea in them all being to "produce simultaneous rupture at two different points in the same circuit." The cut-off used in our own service is a low-tension fuse, identical in construction with that used to fire mines, except that the detonating cap is omitted, and the priming chamber closed with a plug. This fuse forms part of the electrical circuit leading to the mine, and is enclosed in a water-tight box, so that when ruptured the shore end of the cable becomes insulated. When the mine is exploded the bridges of both the mine and the cut-off fuse, being alike in all respects, are simultaneously ruptured—it being understood that the current must be strong enough to *fuse* the platinum bridges. In the English service one cut-off, much like our own, is used, and in another the wire is mechanically broken by using a bit of gun-cotton in the cut-off case. The cut-off may be placed in a water-tight case of its own and anchored near the junction-boxes, but a better arrangement is to place it within the junction-box. Fig. 20 shows how this may be done. The cut represents a circular junction-box for seven cables, *a a a* being the individual mine cables, *b* the multiple cable leading to the firing station, and *c c c* the cut-off fuses. The manner of securing the cables is by means of a collar and turk's-head, as shown.

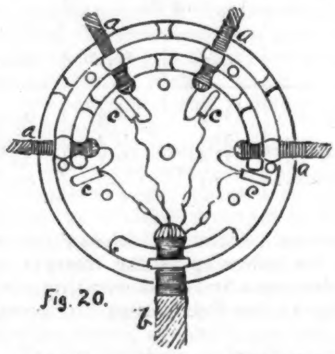


Fig. 20.

(TO BE CONTINUED.)

THE CHIGNECTO SHIP RAILROAD.

THE ship railroad may be said to have its first germ in this country, in the inclined planes built many years ago on the Morris Canal in New Jersey, on which the canal boats were floated into a cage or crib running upon wheels and hoisted up the inclined plane to the higher level of the canal, the power used in most cases being the overflow of water from the upper level. This plan contained really the essential idea of the ship railroad, and in later times engineers have developed the idea and proposed its application in a number of cases. Notable among these was the plan of the late Captain Eads for a line across the Isthmus of Tehuantepec, which was so ably advocated by its distinguished author. Various circumstances have contributed to prevent the construction of any of the proposed lines, but the first ship railroad on a large scale is now approaching completion in Canada.

This railroad extends across the Chignecto Isthmus, which connects New Brunswick and Nova Scotia, and runs

from Amherst, which is at the head of Chignecto Bay, the western arm of the Bay of Fundy, to a point on Baie Verte, an arm of the Northumberland Straits. For many years some method of passing ships across this Isthmus has been talked about, and indeed some communication would naturally suggest itself to any one who studied the map. At its narrowest part it is only 17 miles across, whereas a vessel leaving Amherst for a point on the Straits or in Cape Breton or Prince Edward Island has to undertake a voyage of from 400 to 500 miles, passing the proverbially dangerous coast of Nova Scotia.

The first proposition was for a canal, but while the nature of the ground was not unfavorable, an obstacle was presented by the difference in tide levels. The Bay of Fundy is 21 ft. higher than Baie Verte at high tide and 18 ft. lower at low tide, the extreme variation in the tides at the head of the former being 36½ ft., and in the latter only 5½ ft. The great variation and the rapid rise and fall of the tides in the Bay of Fundy are well known, and would present a serious obstacle to the opening of the canal into that body of water.

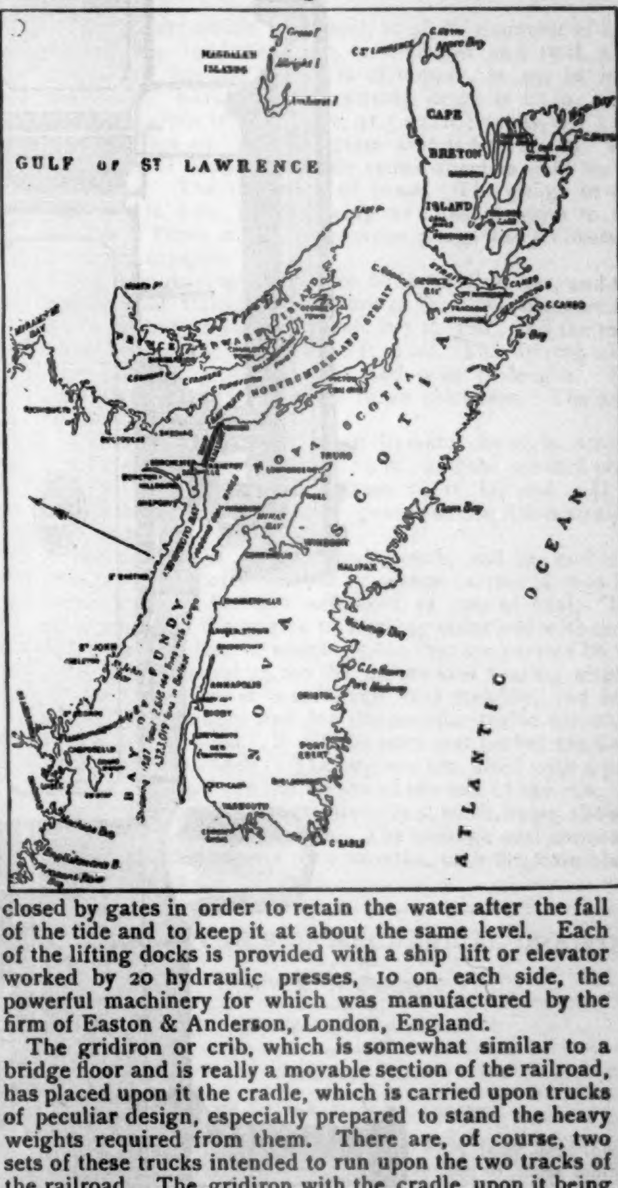
The construction of the Chignecto line is largely due to a Canadian engineer, Mr. Henry E. Ketchum, who first proposed the ship railroad in 1875, and who, by his persistent arguments in its favor, secured support from various influential bodies in Canada. In 1882 the scheme was brought before the Canadian Parliament and provision was then made for a subsidy, the amount of which was fixed at $170,300 yearly for 20 years. Mr. Ketchum's plans and estimates were submitted to the engineers employed by the Dominion of Canada, and later to Sir John Fowler and Sir Benjamin Baker, the well-known English engineers, and secured their approval, and to them in conjunction with Mr. Ketchum was finally committed the execution of the work. The land necessary for the railroad was given by the local authorities, and in 1886 a contract for the construction of the railroad was let to the firm of John G. Meiggs & Son, who began work in the autumn of 1888.

The general situation and relations of the ship railroad are shown in the accompanying sketch map. The traffic which it will carry will undoubtedly be large, and vessels of considerable size are expected to pass over it.

The distance from the head of the Cumberland Basin at Amherst to the terminus at Tidnish on Baie Verte is 17 miles. The ground is generally low, and on the final location it was found possible to make the railroad perfectly straight without any very heavy works. One cutting is required of no very great depth, but of considerable length, while the heaviest bridge work was at the crossing of the Tidnish River. The grades are not heavy, the road being for the most part level, while there is no grade exceeding 10 ft. to the mile. The first necessity in a railroad of this kind is to secure a solid roadbed, and the only difficulty here was in crossing the Tantramar Swamp, where rock filling was employed, and the line was brought up to a level of about 8 ft. above the surface, the amount of filling used being sufficient to leave no doubt that it entirely displaced the soft mud and rested upon solid bottom. At one other point a small swamp was crossed, and there the mud was excavated to hard bottom before filling in for the road-bed.

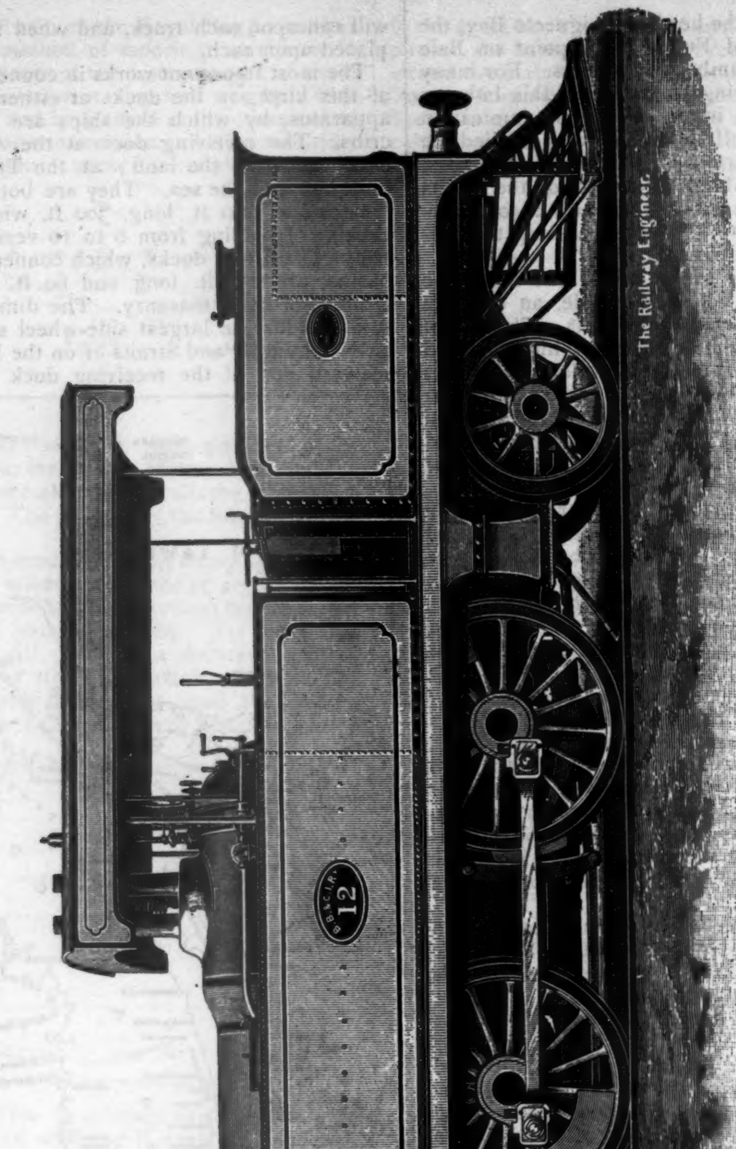
The railroad is constructed with the intention of carrying ships of 1,000 tons register or 2,000 tons displacement. The car or crib carrying the ships runs upon two tracks of the ordinary standard gauge, which are spaced 18 ft. center to center. The rails used for these tracks are probably the largest yet made, weighing 110 lbs. to the yard; they are 6½ in. in height and the joints and fastenings are made heavy in proportion. The ties are of pine 7 × 12 in. and 9 ft. long; at the joints ties 27 ft. in length are used, connecting all four rails. The track will be ballasted with stone throughout. The rails and all the track materials were supplied by Cammell & Company, of Sheffield, England. The car will require two locomotives to draw it at a speed of 10 miles an hour, which is considered the highest that could safely be adopted. Four locomotive tank engines of the Decapod pattern are being constructed for the railroad by the Canadian Locomotive Works at Kingston. In operation one of these locomotives will run upon each track, and when necessary two can be placed upon each.

The most important works in connection with a railroad of this kind are the docks at either end and the lifting apparatus, by which the ships are to be placed in the cribs. The receiving dock at the Amherst terminus is excavated from the land; at the Tidnish terminus it is built out into the sea. They are both of about the same dimensions, 500 ft. long, 300 ft. wide, and 40 ft. deep, capable of holding from 6 to 10 vessels, according to the size. The lifting docks, which connect with the receiving basins, are 250 ft. long and 60 ft. wide, and are constructed of solid masonry. The dimensions adopted are sufficient for the largest side-wheel steamers now in use on Northumberland Straits or on the Bay of Fundy. The seaward end of the receiving dock at Amherst will be



closed by gates in order to retain the water after the fall of the tide and to keep it at about the same level. Each of the lifting docks is provided with a ship lift or elevator worked by 20 hydraulic presses, 10 on each side, the powerful machinery for which was manufactured by the firm of Easton & Anderson, London, England.

The gridiron or crib, which is somewhat similar to a bridge floor and is really a movable section of the railroad, has placed upon it the cradle, which is carried upon trucks of peculiar design, especially prepared to stand the heavy weights required from them. There are, of course, two sets of these trucks intended to run upon the two tracks of the railroad. The gridiron with the cradle upon it being lowered to the bottom of the lifting dock, the vessel is floated in and placed precisely over the cradle, which is then raised to the level of the keel, where the supporting blocks are fitted accurately to the bottom. When it is thus in position, the hydraulic pumps will be started, and in about 10 minutes the gridiron will be lifted to the level of the track with which its own rails coincide. When it reaches this level it will be locked by proper fastenings to the track and to the sides of the dock, and the cradle drawn from the gridiron to the land by hydraulic capstans. The locomotives will be then attached to the car with the ship upon it, and ready to proceed to the other end of the



TANK LOCOMOTIVE FOR SUBURBAN PASSENGER TRAFFIC.

BOMBAY, BARODA & CENTRAL INDIA RAILROAD.

railroad. Here the processes will be exactly reversed. The car being run upon the gridiron, it will be then lowered to the bottom of the lifting dock and the ship floated off and out into the receiving dock.

A traverse table will be provided near the middle point of the line, so that two cars can pass and two ships can be upon the track at once. The cradles are so arranged that they can be fitted to carry two or three small vessels at one trip. These cradles or cars are now being manufactured in England at the works of Handyside & Company in Derby.

As already noted, the heaviest land works were the heavy cutting near Tidnish, which is now completed, and which was about two miles long, and the stone arch bridge over the Tidnish River. The road-bed having a uniform width of 40 ft., this cut required the removal of about 500,000 cub. yds. The other heavy land work was at the Tantramar Swamp, where a large amount of filling was required. The most important works in an engineering point of view are the docks. At the Tidnish end it was found necessary to construct a cofferdam for laying the masonry of the lifting dock. The outer or receiving dock at that point is formed of round timber cribs filled with rock and surrounded by piles of square timber, 12 × 12 in. in size. The upper part or bulkhead is of hewn timber filled in with stone. The basin within these docks is dredged out to a depth of 20 ft. at low water. The receiving dock here is an open basin, no gates being required, as at the Amherst end, on account of the comparatively slight variation of the tide. At the Amherst or Bay of Fundy end the receiving dock is excavated from the land, and is provided with masonry walls and lock gates, as already noted.

The present condition of the work promises an early completion. The Tidnish docks are nearly finished; the Amherst docks are well advanced; the tracks are laid the greater part of the distance across the Isthmus, and the heavy cutting and filling is all done. The contractors expect to have the entire work completed by October next, so that the first ship railroad on a large scale may be in operation before the close of the present year. Of its success as an engineering work there can be no doubt. Financially there are also fair prospects of its success. The whole cost of the work will be about $5,500,000; the operating expenses of the railroad are estimated at $150,000 a year. If only a small percentage of the Canadian coasting trade passes over the railroad, the returns, with a moderate toll, will be sufficient to pay the operating expenses and a reasonable interest on the cost, while the Dominion subsidy will be available for 20 years. Not only will the trade from St. John and the lower ports of the maritime provinces to the St. Lawrence pass this way, but it is thought that coal vessels from Cape Breton will find it to their advantage in many cases to take this route instead of the dangerous Atlantic voyage.

The prospective success and the approaching completion of this work has led to the formation of plans for others of the same kind. The most extensive scheme is for a ship railroad from a point on Georgian Bay to Lake Ontario, which will enable vessels to avoid the long detour through Lake Huron, Lake Erie, and the Welland Canal. This, however, seems to be still very much in the future, as the great cost of so long a railroad will prevent its construction, or at least postpone it for a long time to come.

TANK LOCOMOTIVE FOR SUBURBAN TRAFFIC.

THE accompanying illustration, from the *Railway Engineer*, shows a tank engine designed by Mr. E. B. Carroll, Locomotive Superintendent of the Bombay, Baroda & Central India Railroad, for working the surburban traffic of that road out of Bombay, which is very heavy. The engines were built by the Vulcan Foundry Company, of Newton-le-Willows, England. The suburban trains usually consist of 12 cars, each 27 ft. in length, built on the English pattern, and are fitted with vacuum brakes. The distance run is 10 miles, with stations averaging three-quarters of a mile apart, so that an engine which can start quickly is needed for the work. The road is level, but has some sharp curves.

The pattern of engine adopted, as will be seen from the engraving, has four driving-wheels coupled, with inside cylinders, and two bearing axles, one under the smoke-box and the other under the rear tank. These bearing wheels are fitted with radial axle-boxes of the pattern used by Mr. Webb in England, giving the engine considerable flexibility. The cylinders, as before stated, are inside, with the steam-chests on the side, so that the two steam-chests come back to back in the center. Water is carried in two side tanks and in a rear tank, and fuel in the box over the tank on the back end of the frame. The frames are of the plate type, and are carried back behind the fire-box to support the tank. The engine is not provided with a close cab on account of the great heat of the climate, but with simply a roof supported by steel rods rising from the tanks.

The boiler, which is of steel, is 48 in. diameter of barrel, and has 168 tubes 2 in. in diameter and 10 ft. 3 in. long. The fire-box, which is of copper, is 49½ in. long and 48½ in. wide, and its extreme depth is 62 in. The heating surface is: Fire-box, 91.5 sq. ft.; tubes, 901.5 sq. ft.; total, 993 sq. ft. The grate area is 63.8 sq. ft. The fire-box is of copper, and the crown-sheet is held up by steel stays. The tubes are of brass. The gauge of the road is 5 ft. 6 in., this allowing an unusual width to the fire-box. There is one long-stroke pump and a Gresham & Craven injector.

The four driving-wheels are 60 in. in diameter, and the leading and trailing wheels are 42 in. The distance between centers of driving-wheels is 7 ft. 3 in., and the total wheel base of the engine is 20 ft. 9 in. The driving-axles have journals 7 in. diameter and 9 in. in length. The steel plate of the frames is 1 in. in thickness. The axle-boxes are of cast steel.

The cylinders are 17 in. in diameter by 24 in. stroke. The steam-ports are 1⅝ in. × 14 in., and the exhaust ports 4 in. × 14 in. The valves have 1¼ in. lap and 4 $\frac{1}{16}$ in. maximum travel. The valve gear is of the Allan straight link type.

The side tanks hold 200 gals. each, and the end tank 400 gals.; the total amount of water carried is thus 800 gals., and the fuel-box will hold 2½ tons of coal. The total weight of the engine in working order and with tanks full is 101,000 lbs., of which 55,800 lbs. are carried on the driving-wheels and 42,200 lbs. on the four bearing-wheels.

These engines, it is said, run very steadily, and have worked remarkably well for the peculiar traffic for which they were intended. It will be seen that brakes are fitted to the driving-wheels. The engines are fitted with a pilot at each end, and are not turned at the end of the run. In service they are kept pretty steadily at work, being allowed but little time between runs. The average coal consumption of one of them for nine months, with the train above noted, was 32 lbs. per mile.

THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

(*Continued from page* 88.)

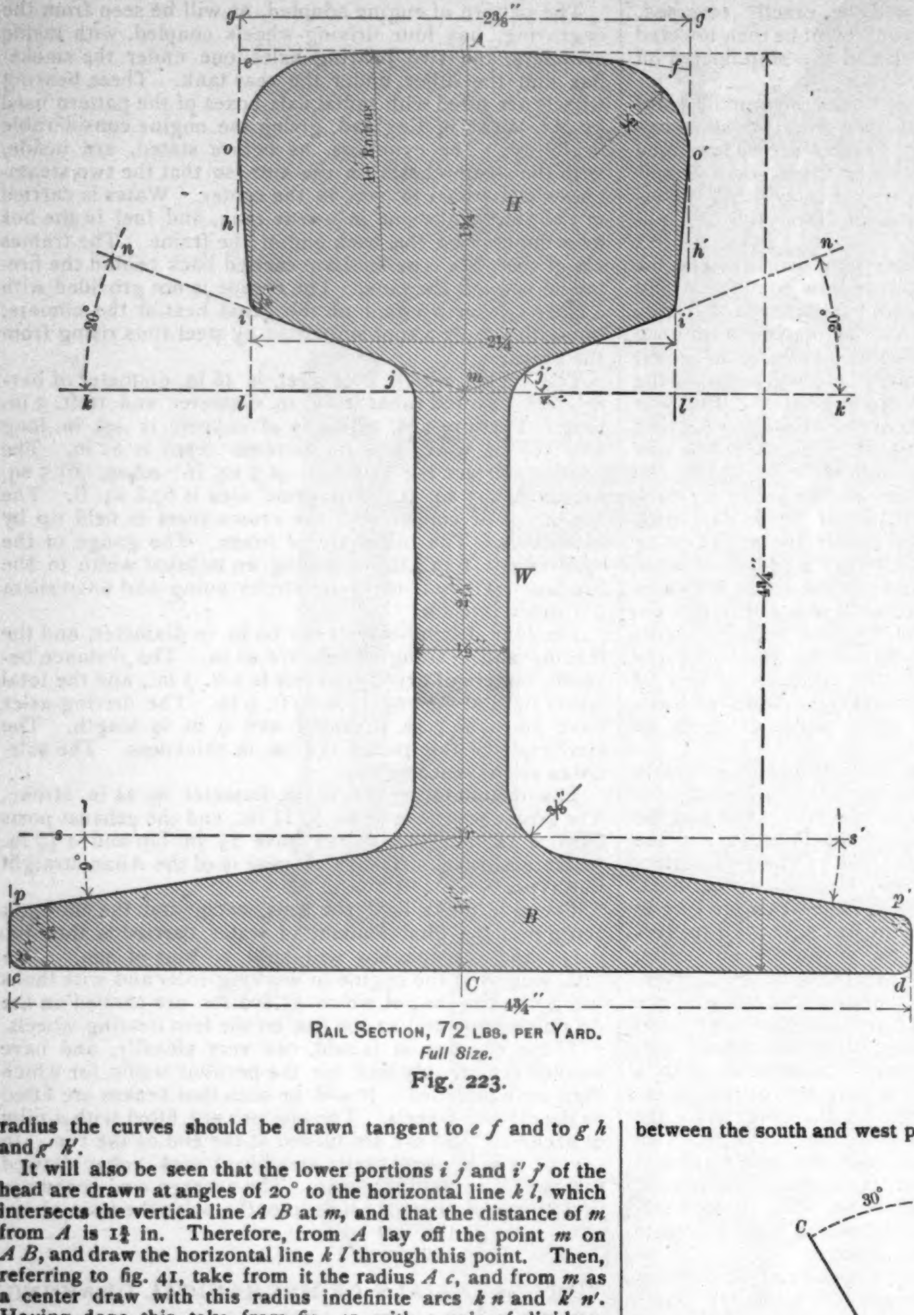
CHAPTER VIII.

THE DELINEATION OF ANGLES.

THE methods of laying out angles were fully described in Chapter III. Some illustrations of the use of those methods will be given here.

Fig. 223 represents a section of a railroad rail drawn full size. In drawing this the first step is to lay down a vertical center line, *A B*. At any convenient point, as *B*, near the lower end of *A B*, draw a horizontal line *c d*, to represent the bottom of the rail. From the intersection *B* of *A B* with *c d* lay off the width *c d* of the base of the rail, and its height *B A*, each equal to 4½ in. It will be noticed that the top of the rail head is curved, the curve being drawn with a radius of 10 in. With this radius find a center on the vertical center line *A B* extended below *B*, at a distance of 10 in. from *A*, and draw the curve *e f*.

The width of the top of the head of the rail, it will be seen, is 2⅜ in. Lay off half this dimension on each side of *A*, and draw vertical pencil lines *g h* and *g′ h′*. The curves of the two upper corners of the head are arcs of circles of ¼-in. radii. With this



RAIL SECTION, 72 LBS. PER YARD.
Full Size.
Fig. 223.

radius the curves should be drawn tangent to *e f* and to *g h* and *g' h'*.

It will also be seen that the lower portions *i j* and *i' j'* of the head are drawn at angles of 20° to the horizontal line *k l*, which intersects the vertical line *A B* at *m*, and that the distance of *m* from *A* is 1⅝ in. Therefore, from *A* lay off the point *m* on *A B*, and draw the horizontal line *k l* through this point. Then, referring to fig. 41, take from it the radius *A c*, and from *m* as a center draw with this radius indefinite arcs *k n* and *k' n'*. Having done this, take from fig. 41, with a pair of dividers, from *c*, on the circumference of the large circle, the distance to the point marked 20, or 20° of the circumference, and lay this off from *k* and *k'* to *n* and *n'*. Then, from *m* draw *m n* and *m n'*. These lines will then be at an angle of 20° with *k k'*.

The sides of the head of the rail, it will be seen, slope inward from the top, so that the lower part of the head is narrower than the top. The width below is 2¼ in. This may be laid off from *m* on *k k'*, and vertical lines *l i* and *l' i'* should be drawn through *l* and *l'*. As the lower corners of the rail are rounded with curves of 1/16 in., these should be drawn tangent to *i l* and *n m* and to *i' l'* and *m n'*. The curves of the upper corners and those of the lower ones may then be united by the lines *o i* and *o' i'*.

The *stem*, or *web*, *W* of the rail is ½ in. thick, and is represented by two vertical straight lines.

The top *p r* and *p r'*, it will also be seen, is drawn at an angle of 9° to the horizontal line *s s'* which intersects *A C* at *r*, which is 11/16 in. above the bottom of the base at *C*. These angulated lines may be drawn in the manner already described. The lower portion of the head is then united to the web with curves drawn with ¼ in. radius, and the top of the base is also united to the stem or web with curves drawn with ⅝ in. radius. Rounding the outer corners of the base with curves drawn with 1/16 in. radius completes the section.

In ruling the section of the rail, the lines should be drawn further apart than they are shown in the engraving; if drawn in this way it will require less time and skill to do it neatly, and will answer the purpose equally well, or better than the fine ruling will.

PLOTTING SURVEYS.

In measuring the surface of ground the direction of the lines are always ascertained by means of a surveyor's compass. Lines running north and south are assumed, and such lines are called *meridians*. A line traced or measured on the ground is called a *course;* and the angle which this line makes with the meridian passing through the point of beginning is called the bearing. Thus, let the line *N S*, fig. 224, represent a meridian. Then, if we start from the point *A* and measure in the direction *A B*, the line *A B* is the *course*, and the angle *N A B* is the *bearing*.

When the course, like *A B*, falls between the north and east points, the bearing is read, *north* 46° *east*, and is written, *N.* 46° *E.* That implies that the direction of the line from its point of beginning is northward and eastward, and that the angle *N A B* = 46°.

When the course, like *A C*, falls between the north and west points, the bearing is read, *north* 30° *west*, and is written, *N.* 30° *W.* This implies that its direction is northward and westward, and the angle *N A C* = 30°. When the course, like *A F*, falls between the south and east points, the bearing is read, *south* 70° *east*, which is written, *S.* 70° *E.*, and the angle *S A F* = 70°. When the course, like *A D*, falls between the south and west points, the bearing is read, *south* 60°

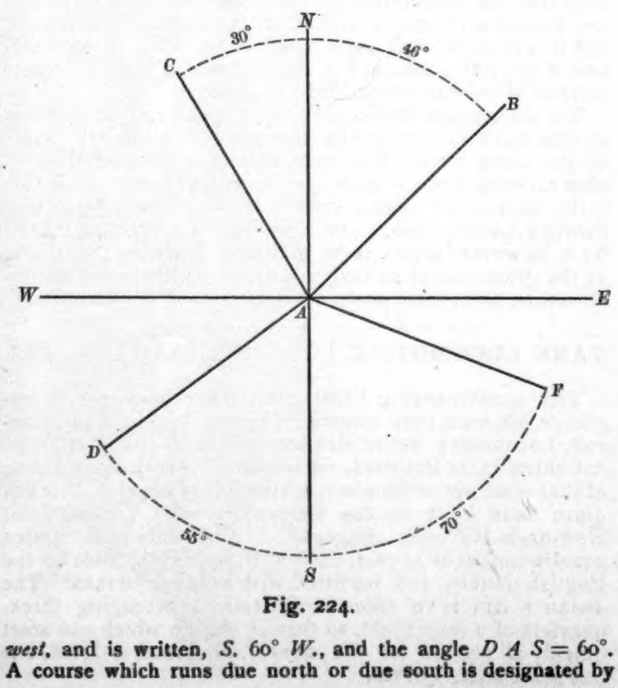


Fig. 224.

***west*, and is written, *S.* 60° *W.*, and the angle *D A S* = 60°. A course which runs due north or due south is designated by**

No. 1.—ROMAN.

A B C D E F G H I J K L M N
O P Q R S T U V W X Y Z &

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n o p q r
s t u v w x y z

No. 2.—TITLE.

A B C D E F G H I J K
L M N O P Q R S T U
V W X Y Z &

1 2 3 4 5 6 7 8 9 0

No. 3.—CELTIC.

A B C D E F G H I J K L
M N O P Q R S T U
V W X Y Z &
1 2 3 4 5 6 7 8 9 0

No. 4.—ITALIC.

A B C D E F G H I J K L M N
O P Q R S T U V W X Y Z &

a b c d e f g h i j k l m n o p q r
s t u v w x y z

No. 5.—GOTHIC.

A B C D E F G H I J K L
M N O P Q R S T U
V W X Y Z &

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n o
p q r s t u v w x y z

No. 6.—GOTHIC EXTENDED.

A B C D E F G H I J
K L M N O P Q R S
T U V W X Y Z &

the letter *N.* or *S.*, and one which runs due east or due west by the letter *E.* or *W.**

Let it be supposed now that we have a piece of land bounded and described as follows: Beginning at a stone for a corner, at 1, fig. 225, N. 31½° W., ten chains to a white oak tree, at 2; thence N. 62¾° E. 9.25 chains to a post; thence S. 36° E. 7.60 chains to a boundary stone at 3; and thence S. 45½° W. 10.40 chains to the place of beginning.

To make a plan of such a piece of land, or to *plot* it, as it is

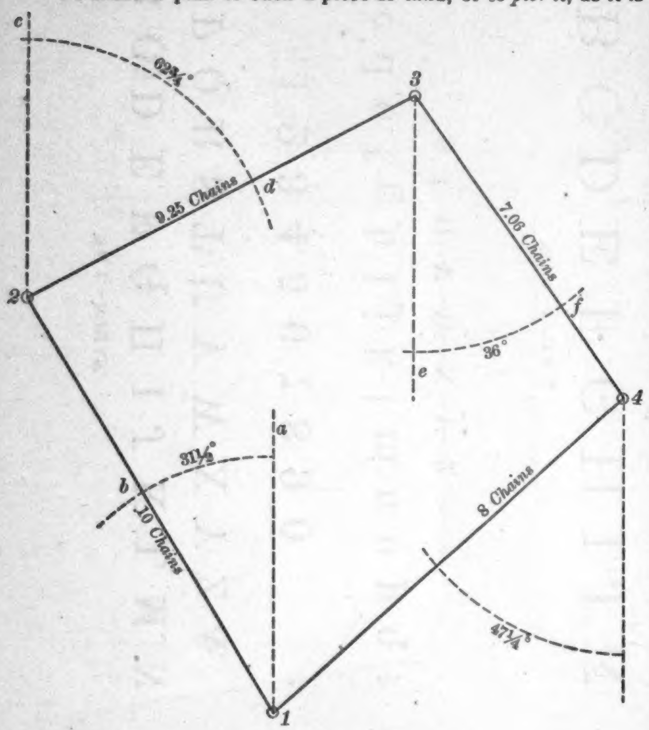


Fig. 225.

called, first fix upon a scale—in the present instance ½ in. = 1 chain. Then, through the point of beginning 1, draw a straight line *a* 1, to represent a meridian, or north and south line. From 1 lay off the angle *a* 1 *b* = the bearing on the left or west side of the meridian, above or north of 1, and measure off the first distance or course 1 2 equal to 10 chains on the line 1 *b* extended. Then draw another line or meridian 2 *c* through 2 and parallel to 1 *a*, and lay off the angle *c* 2 *d* north and east of 2 *c* = 62¾° = the second bearing, and measure off on 2 *d* extended the distance 2 3, 9.25 chains = the second course. Through 3 draw the meridian 3 *e* and proceed as before, noting that as the third bearing is *S.* and *E.*, that the angle *e* 3 *f* must be laid off below or south, and on the right-hand side or east of 3. The meridians must, of course, all be parallel to each other. Ordinarily, lines drawn perpendicular to the lower edge of the paper are the most convenient for the representation of meridians, but this is not essential.

When the last course, 4 1, is drawn, it should join the first and last stations 4 and 1. If it does not, and there is an open space between 1 and the extremity of the last course, it shows that there is either an error in the measurement of the land or in the drawing. Methods of correcting errors in the measurement of land are given in the books on surveying, to which those in search of further information on the subject are referred.

CHAPTER IX.

TITLES AND LETTERING.

A drawing should *always* have a descriptive title, the scale to which it is made and the date when it was finished distinctly inscribed on it. Each of these is important, although at the time the drawing is completed it may not appear so. The student will realize this if he has occasion to make use of old drawings, decipher their meanings or ascertain what they represent. When they have just been completed, all this information is fresh in the minds of those interested, or can be easily learned; but in time all recollection of them will have faded away or literally be buried with those who were possessed of the knowledge. It is often of the utmost importance to know whether a drawing represents a part of one machine or a part of another. If no dimensions are given, it is difficult, and sometimes impossible, to ascertain the scale to which a drawing was made, and often the date is of vital importance. This is especially the case with patent drawings. A draftsman should make it a rule never to allow a drawing to leave his hands without putting a title, the scale, and the date on it. If he is too busy to give more than a very little time to it, he should write it on with a pen or pencil hastily. This may be of great importance in the future. The style of the lettering is very seldom a matter of much consequence, but that the exact object represented, the scale, and date should be known is often of vital importance.

With reference to the subject-matter of titles, no general directions can be given. In this the student must be guided by his own common sense and perspicuity. The title of a drawing should always be capable of conveying to a person without more than a general knowledge of it exactly what it represents. The date and scale are usually given on a line below the title.

As remarked by a writer* on this subject, the plainer the lettering on a mechanical drawing the better. Most young draftsmen, in the exuberance of youth, are ambitious to add highly ornate titles to their finished drawings. This is a juvenile malady which it is perhaps not always best to check, and which leaves no ill effects after, but is sure to disappear in the companionship of hard work. While elaborate lettering is not to be recommended, it is also true that if it is carelessly or awkwardly done it detracts very much from the merits of a good drawing.

As mechanical drawings are constructed in accordance with strict geometrical rules, the lettering on them should have a similar character. For this reason what are known as Gothic letters are the most suitable, of which examples are given in the sample alphabets herewith. The style which can be done most quickly and easily is what is known as "*slant Gothic*," No. 8, For outline drawings, outline letters, similar to No. 7, look well, as they are less conspicuous than those which are drawn in solid black. Italic letters are more easily drawn with an ordinary writing pen, if a person once acquires the skill to make them neatly. The "bulletin" letters, No. 10, can also be made quickly.

In lettering, rules will be found to be of little use. Neat work is chiefly dependent upon skill, as ordinary writing is, and that, in turn, is usually the result of practice, although natural aptitude has much to do with it. It has been remarked that skill in lettering and a good ear for music are usually found in the same person.

If lettering is to be done neatly two parallel pencil lines

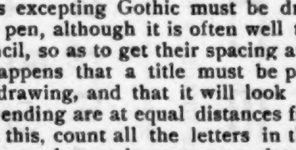


Fig. 226.

should be ruled to define the height of the large letters, and if small ones are used, another line should be drawn between the two for their height, as in fig. 226. If Gothic letters are used, or any other style the outlines of which are straight lines, which can be drawn with a ruling pen, they should be sketched in with a pencil, the spacing and proportions of the letters being done with the eye. The outlines, or those consisting of straight lines, can then be drawn with a ruling pen. Italic and most other styles of letters excepting Gothic must be drawn with an ordinary writing pen, although it is often well to sketch them in first with a pencil, so as to get their spacing and position right.

It usually happens that a title must be placed in a central position on a drawing, and that it will look much better if its beginning and ending are at equal distances from a center line. To accomplish this, count all the letters in the title and count the spaces between the words as so many letters. Then ascertain the middle letter or space, and, beginning with that, place it on the center line, or, if there are an even number of letters, place the middle space between the letters on the center and sketch in the title with a pencil from the middle to the end. Then lay off the distance from the middle to the end on the left side of the center, and, beginning from the point thus laid off, sketch in the first part of the title. The scale and the date and if there is anything else included in the title should be laid off in a similar way, so as to be symmetrical. When this is done, the lettering may be finished with ink. For fine lettering, Gillott's No. 303 Extra Fine writing pens are very good.

To become skillful in lettering, the student must practise the art. He should take a sheet of paper, and, after ruling it so as to give the size of the letters, imitate some or all of the alphabets given herewith. In this, as in many other things, the old adage, "if at first you don't succeed, try, try again," is the best instruction.

* John Maxton, engineer, in "The Workman's Manual of Engineering Drawing."

* Davies's "Surveying."

No. 7.—GOTHIC CONDENSED.

A B C D E F G H I J K L M N O P
Q R S T U V W X Y Z &

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n o p q r s
t u v w x y z

No. 8.—GOTHIC ITALIC.

A B C D E F G H I J K L M N O P Q R S T
U V W X Y Z &

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n o p q r s t u v w
x y z

No. 9.—GOTHIC SHADED.

A B C D E F G H I J K L M N
O P Q R S T U V W X Y Z &

No. 10.—BULLETIN.

A B C D E F G H I J K
L M N O P Q R S T
U V W X Y Z

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n
o p q r s t u v w x z

No. 11.—ARABESQUE.

A B C D E F G H I J K L M N O P
Q R S T U V W X Y Z &

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n o p q r s t u v w
x y z

A number of alphabets are given herewith; space prevents our giving more in this number, but others will be given hereafter.

(TO BE CONTINUED.)

Tests of Varnish.

(Paper read before the Master Car & Locomotive Painters' Association, by Mr. A. T. Schroeder, Master Car Painter, Chicago, Milwaukee & St. Paul Railroad.)

MR. J. N. BARR, our Superintendent of Motive Power, being of the conviction that it was the only way to arrive at conclusions in adopting standard material, instructed me to test all of our paint material, and, as varnish is one of the most important materials, it was concluded, in order to obtain the relative merits of the various varnishes, to finish every car, wherever practicable, with two varnishes; that is to say, one-half of the car with one brand, the other half with another brand, in such a way that every long side of a car should show the two varnishes as they meet in the center. Thus it would be plainly demonstrated by the material itself which of the two, in a certain length of time, would prove to be preferable.

From the fall of 1886 to the close of 1889 more than 200 cars were finished in this way, and altogether 17 different brands applied. It was clearly demonstrated that several of these, to put it mildly, were not at all adapted for that purpose, and they consequently had to be discarded; finally the brands were reduced to a limited number, and one of these, which had proved so far to be the best one in all respects, was put in competition with all the remaining ones. Up to now we have not arrived at a final conclusion, because of the many circumstances to be taken into consideration, but during my experience in testing varnish in this manner facts were revealed of which I never heretofore dreamed.

Our standard for sleeping, dining and parlor cars is Pullman color; the ornamentation applied on the flat paint and the car then finished with one coat of rubbing and two coats of finishing varnish. Passenger, baggage and other cars are painted yellow, last coat varnish color, of the formula of 1 lb. paste body color, 1½ lbs. rubbing varnish and 2 oz. turpentine; then ornamented and finished with two coats finishing varnish.

At the suggestion of Mr. Barr we took a few cars and varnished them with one brand for the whole car, but used for one-half of the car one coat of rubbing and one coat of finishing varnish, and for the other half two coats of finishing varnish, in order to ascertain which process would give the best results. This was done accordingly. After a very short time the difference was so manifest that the one-half on which rubbing varnish had been used lost so much of its luster that it showed a marked dividing line in the center of the car, and after a few months longer the contrast had so increased as to make it appear as though originally only one-half of the car had been varnished. Naturally such a car was immediately called in for revarnishing. On other cars which had to stay on the road from 16 to 20 months such difference could not be distinguished, as all luster had disappeared, yet I observed that the half with the rubbing varnish over the gold was in a more advanced state of decay than on the other half, where two coats of wearing body varnish had been applied. Furthermore, a difference in favor of the latter was found when I applied the so-called oil test, of which I will make mention later on.

Now about these cars on which two brands were used, each car finished with two coats of wearing body varnish. In regard to the luster it was very difficult to discover any difference, whereas on the yellow car it was found, after careful investigation, that some brands were superior in transparency. Yet I think this is only a matter of secondary consideration, as durability is certainly the most important object.

The oil test is as follows: After 10 months of service a car arrives at the shop: both varnishes have the same appearance and surface, and no difference in the two varnishes can be noted. I then have a vial filled with half-and-half boiled and raw linseed-oil, and a 2-in. long round wire nail, driven into the cork and extending into the oil. With this nail I take out a drop of oil and apply it on the varnish, making drops of various sizes, so that I may be able to note how much, if any, of this oil will penetrate into, or spread out on, the varnish. After four or five hours I find that on the one varnish the oil has entirely penetrated and scarcely left a visible trace, whereas on the other varnish the oil remains as applied, thus showing that no absorption whatsoever has taken place. Which of the two varnishes should have the preference? Which one will protect paint and wood best I need not say.

On another car, one-half is in best condition, paint as well as varnish; but on the other half long cracks, running with the grain of the wood on the panels, draw through them, which, upon examination, are found to extend deep into the paint. Is the paint responsible for the cracking? I cannot believe so. The whole car was painted with the same paint at the same time and under like conditions. But, supposing that the whole car had been varnished with that one brand, would not the painter have to carry the blame? How could he prove the contrary? Who would believe him?

Of course, by testing varnish in this manner, many cars were utterly spoiled, and we had to remedy the evil as quickly as possible. It would be useless to recite the results of all of these various cases; suffice it to say, that it has brought to light many interesting facts, and although I was not able to examine all of these 200 cars, a great number of them enabled me, upon examination, to form a correct opinion as to the merits of the material.

Lake Shipbuilding.

(From the Cleveland *Marine Review.*)

WITHIN the last five years the tonnage of the lakes has been more than doubled, and it is interesting to note this wonderful growth in new ships from reliable sources. In the spring of 1886 began an era of profitable freights and with it the displacement of the small wooden boats by big steel carriers. As a result ship-building has been carried on to such an extent as to cause some fears of overproduction. The new tonnage to be floated next spring, however, will fall but short of previous years, and this is saying a great deal when the figures are considered. In a synopsis of the forthcoming report of William W. Bates, Commissioner of Navigation, shipbuilding returns for three years past are given, and by reference to former reports the following table, showing the work of five years, is secured:

	No. of Boats.	Net Tonnage.
1886	85	20,400.54
1887	152	56,488.32
1888	222	101,102.87
1889	225	107,080.30
1890	218	108,525.00
Total	902	393,597.03

The following table, from the same source, shows the tonnage of vessels built in the United States from 1857 to 1890, and it is remarkable that the increase on the lakes in the past five years—393,597 tons—is equal to that of 12 years previous:

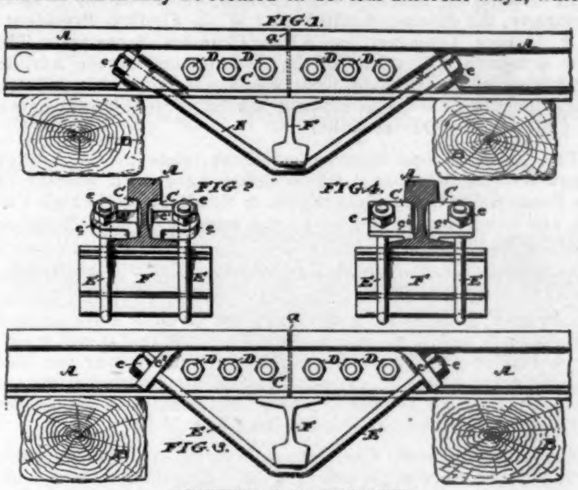
YEAR ENDING JUNE 30.	On the Great Lakes.	On the entire Seaboard.	On the Mississippi River and its Tributaries.	Total.
	Tons.	Tons.	Tons.	Tons.
1857	51,498	285,453	41,854	378,805
1858	31,642	177,412	35,659	244,713
1859	6,180	133,294	17,128	156,602
1860	11,992	169,836	32,970	214,798
1861	23,467	179,767	29,960	233,194
1862	53,804	112,487	8,785	175,076
1863	67,972	215,667	27,407	311,046
1864	49,151	310,421	56,169	415,741
1865	36,641	291,306	66,576	394,523
1866	33,204	232,388	70,555	336,147
1867	39,679	230,810	35,106	305,595
1868	56,798	175,812	52,695	285,305
1869	49,460	191,194	34,576	275,230
1870	37,258	182,836	56,859	276,953
1871	43,897	156,249	73,081	273,227
1872	44,611	128,097	36,344	209,052
1873	92,448	218,139	48,659	359,246
1874	91,986	277,093	63,646	432,725
1875	29,871	244,474	22,294	297,639
1876	16,124	163,826	23,636	203,586
1877	8,903	132,996	34,693	176,592
1878	11,438	155,138	68,928	235,504
1879	15,135	115,683	62,213	193,031
1880	22,899	101,720	32,791	157,410
1881	73,504	125,766	81,189	280,459
1882	58,369	188,084	35,817	282,270
1883	28,638	210,349	26,443	265,430
1884	30.431	178,419	16,664	225,514
1885	26 826	121,010	11,220	159,056
1886	20,400	64,458	10,595	95,453
1887	56,488	83,061	10,901	150,450
1888	101,103	105,125	11,859	218,087
1889	107,080	111,852	12,202	231,134
1890	108,525	169,089	16,505	294,119

The comparison between lake and coast building in the foregoing table is particularly flattering to the inland seas. During the past few years the work of the lake ship-yards has been fully equal to that of the Atlantic Coast and almost equal to the entire coast work, while in the previous period of 20 years there was no comparison between them, on account of the big output on the Atlantic.

Recent Patents.

CONNELL'S RAIL-JOINT.

THE accompanying illustrations show a rail-joint invented by William H. Connell, of Wilmington, Del., and covered by Patent No. 439,116. The nature of the invention can be easily understood from the drawings, in which figs. 1 and 3 are side elevations and figs. 2 and 4 end elevations of the joint. It will be seen that it is a truss joint, the fish-plates having a lug on each end which may be formed in several different ways, which

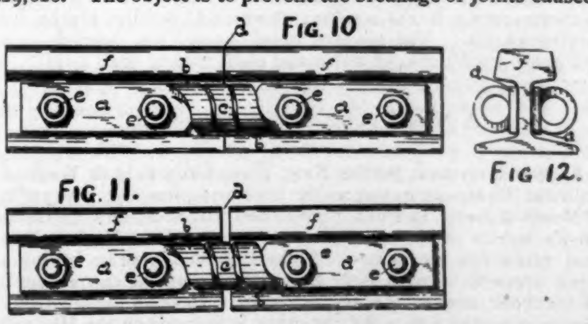


CONNELL'S RAIL-JOINT.

will readily suggest themselves. Through these lugs pass the tie-rods or truss-rods *E E*, which are held by the nuts *e e*, thus giving additional strength and support to the joint. The angle bars are bolted in the ordinary way through the rail by the bolts *D D D*. The truss-rods pass under the strut *F*, which, as shown in the drawing, is a short piece of rail. Old rails can very well be utilized for this purpose, but, of course, the strut can be made of any other suitable form. In adjusting the joint the splice-bars *C* are first secured to the rails by the bolts, the tie-rods *E E* being inserted in the lugs of the splice beforehand. The strut *F* is then stepped beneath the joint in the proper position and the nuts *e e* are screwed up, forcing the strut up against the bottom of the joint between the rails and making a joint which, the inventor claims, will be very strong, stiff, and compact.

HUNLOCK'S RAIL-JOINT.

Figs. 10, 11, and 12 show a form of rail-joint patented by John G. Hunlock, of Wyoming, Pa., the patent being No. 429,628. The object is to prevent the breakage of joints caused



HUNLOCK'S RAIL-JOINT.

by contraction and expansion by interposing a spring; this is effected by forming part of the splice-bar into a coiled spring as shown.

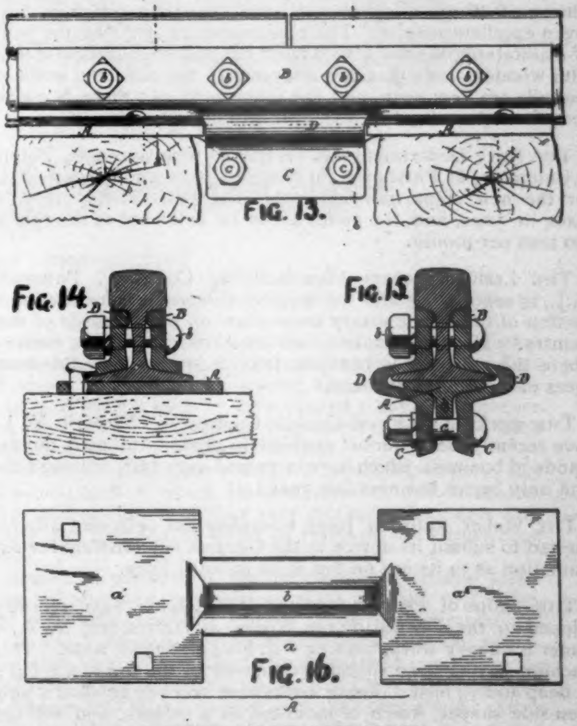
In the illustrations fig. 10 is a side view of the two ends of the rails at the joint with the plate in place, showing the condition of the joint when the rails are fully expanded. Fig. 11 is a side view of a similar joint, showing its condition when the rails have become somewhat contracted by a change of temperature or from other causes. Fig. 12 is an end view of the rail with plates in place, bolt-heads having been omitted. In these *a* and *a* are the flat ends of the plate through which the bolts go, by which the plates are bolted to the rails; *f* and *f* are the ends of the rails, to which are bolted the plates; *b b* and *c* compose an intermediate part of the plate between the two ends or arms *a*, and are formed into a helix branching from *a* at *b* with an enlarged section. It is gradually reduced in section until at the point *c* it has attained its smallest section. The object of this gradual reduction in section is to obtain a maximum elasticity in the central coil, where only a torsional or twisting strain is produced. In order to reduce the transverse or bending strain at the junction of *b* with *a*, *e e e e* are the bolts by which the plates are held in place; *d* indicates the opening between the ends of the rails.

CHURCHILL'S RAIL-JOINT.

A form of rail-joint covered by patent No. 433,273, issued to Charles S. Churchill, of Roanoke, Va., is shown in figs. 13–16. Fig. 13 is an elevation; fig. 14 a section through the tie; fig. 15 a section through the bridge-plate; fig. 16 an inverted plan of the bridge-plate.

The bridge-piece *A* consists of a plate of iron or steel formed of a narrow central section *a*, provided with a strengthening-rib *b* on its under side, and two broad end sections a' a^2, extending over and adapted to be secured to the ties. By this construction the weight of the rail and train is distributed over a large surface of the ties, while the ribbed-bridge portion is sufficiently strong, in connection with the angle-bars, to withstand the weight of the rails and train and transmit it to the ties.

The angle-bars or fish-plates are of the peculiar construction best shown in fig. 15, each consisting of an upper part *B* and a lower part *C*, connected together by an outwardly curved and inclined portion *D*, embracing both the bridge-piece and the lower flange of the rail. The parts *B* extend for a considerable distance along the sides of the rails, in the manner common to ordinary fish-plates, and are secured to the rails and to each other by bolts b'. The parts *C* are made short enough to fit in between the adjoining ties, and the bolts *c*, which serve to bind them together, pass beneath the ribbed bridge-piece, as shown



CHURCHILL'S RAIL-JOINT.

in fig. 15, or through the same. It will also be noticed that the inclined portions *D* of the angle-bars fit snugly against the inclined flanges of the rail and the inclined under side of the bridge-piece *A*, so that when the bolts *b* and *c* are tightened the parts are pressed into close contact and the whole structure is bound firmly together, preventing the deflection of the rail ends or the creeping of the rails.

Manufactures.

General Notes.

THE Berlin Iron Bridge Company has increased its capital stock from $125,000 to $300,000, the new stock being all taken by the old stockholders. The additional capital will all be invested in improving and enlarging the plant at East Berlin, Conn., where work will be begun at once on a new building 80 × 600 ft. in size.

THE shops of H. K. Porter & Company, in Pittsburgh, have completed two Forney locomotives of 4 ft. gauge for the United States Government. These locomotives are for the Muscle Shoals Canal improvement in Alabama, and are to be used for towing barges through the canal. Each locomotive is fitted with four heavy hooks to which the tow lines are connected.

THE Wason Manufacturing Company, Brightwood, Mass., is building 20 passenger cars for the Old Colony, 20 for the New York, New Haven & Hartford, and 50 for the Manhattan Elevated Railroad.

THE Scarritt Furniture Company, St. Louis, has recently received orders for Scarritt-Forney seats for 10 cars for the Chicago & West Michigan; also for 79 new coaches now building for the Chicago & Northwestern Railway.

THE New Orleans & Northeastern Railroad, which has some 20 miles of trestle running through the swamps back of New Orleans and over Lake Pontchartrain, has set about the task of filling in the trestle with dirt. This is being done by a new patent dredge boat built by the Bucyrus Steam Shovel & Dredge Company, which is showing itself a wonder in the matter of thowing up dirt, excavating a canal on the side of track, and piling up the dirt under the trestle with great rapidity. The embankment, while proving of great benefit to the railroad, would also advantage New Orleans, since it will serve as a levee to prevent any overflow from Lake Pontchartrain when that lake is swollen by northwest winds.

THE ties made by the Standard Metal Tie & Construction Company, of New York, which were laid in the track of the Chicago & Western Indiana Railroad some 15 months ago, have given excellent results. The roadmaster reports that the work of maintaining the track with these ties has been much less than with wooden ties; they are more easily tamped; the heads of the rails are kept even, and the joints held up; there is no deflection of the rails, and less wear on the rail ends.

THE Navy Department has contracted with Carnegie, Phipps & Company, of Pittsburgh, to furnish 6,500 tons of armor plates for the new ships now building. The first delivery is to be made in June, and the plates are to be delivered at the rate of 500 tons per month.

THE Leslie Brothers Manufacturing Company, Paterson, N. J., is negotiating with the Russian Government for the introduction of the Leslie rotary snow-plow on the railroads of that country. The importance of an improved plow in a country where the snow-fall is heavy is fully appreciated by the managers of the State Railroads.

THE works of the Flood-Conklin Company in Newark, N. J., have recently been almost doubled in capacity to meet the demands of business, which have increased very fast, although the firm only began business last year.

THE Weber Railroad Joint Company has been officially requested to submit its device to the German Government for examination as to its use on the State railroad lines.

THE shops of Pedrick & Ayer, Philadelphia, have recently shipped to the Central Forge Works, at Whitestone, N. Y., a planer for heavy work, planing 8 ft. long and 25 in. wide. This machine, having been specially designed for the work, will cut $\frac{5}{8}$ in. deep and $\frac{1}{16}$ feed. These works have recently finished a new open-side shaper, which is mounted on a column, and will cut 14 × 14 in. square and 31 in. in length, and which is an exceedingly convenient tool for general use.

THE boilers of the steamer *Phra Nang*, which were fitted with the Servé ribbed tubes by the Fairfield Ship-building Company, have now been used in a passage out to China, and the engineer reports that they behaved very satisfactorily, and caused an appreciable saving in coal consumption. An exact estimate will not be made until the vessel has been at work for three months in her regular trade in the China Seas. The boilers fitted with the Servé tubes in the works of John Brown & Company, in Sheffield, have been submitted to continued tests, the latest showing, under high induced draft, a relative economy of 15 per cent. for the ribbed tubes. These tubes have already been described in the JOURNAL, and are to be introduced in this country, Mr. Charles W. Whitney, of New York, having taken the agency for the same in the United States.

THE automatic temperature regulator of the Consolidated Car Heating Company is now in use by the Wagner Palace Car Company, and on the Boston & Maine, the Fitchburg, the Buffalo, Rochester & Pittsburgh, the Baltimore & Ohio, and the Delaware & Hudson Canal Company's road. The company's fire-proof heater is now in use on the New York, Providence & Boston, the Boston & Maine, the Intercolonial, and the Lehigh Valley roads, and by the Wagner Company.

THE business of the Dunham Manufacturing Company has been transferred to a new organization, known as the Q. & C. Company, the officers of which are: W. L. Findley, President; C. F. Quincy, Treasurer, and Arthur Crandall, Secretary. The new company will continue the manufacture of the various articles which the Dunham Company has introduced in railroad work, including car doors, brake adjusters, ventilators, the Servis tie-plate and the Davies spike.

THE portable rope hoisting machines made by the Energy Manufacturing Company, Philadelphia, have been adopted by the Pennsylvania, the Philadelphia & Reading, the Lehigh Valley, and other roads, and by a large number of manufacturing establishments.

A NEW system of ventilation for fruit and other cars has been devised by Mr. R. M. Pancoast, of Camden, N. J. It can be readily applied to existing cars, and the inventor claims that it will not only admit air and exclude dust, but that it will maintain a sudden circulation of air passing directly over the load and will carry off all impure air, keeping the interior of the car cool and fresh, a condition which is essential to the proper transportation of fruit and similar freight.

THE Consolidated Car Heating Company has recently equipped a number of private cars, including one built for Austin Corbin; one for the President of the Canadian Pacific; one for the New York, Lake Erie & Western; one for the Lehigh Valley; several pay cars of the New York Central & Hudson River Railroad have been equipped with the consolidated commingler system. The Delaware & Hudson Canal Company has recently changed its Albany Belt Line trains from direct steam to the commingler storage system, with temperature regulator. The piping formerly in the cars was used, and they are now heated at will by direct steam, or by circulating hot water. The Canadian Pacific and the "Soo" lines have recently given considerable contracts for car heating to this company, which has also new orders on hand from the Boston & Maine, the Old Colony, the Fitchburg, and the Grand Trunk. On March 11 and 12 the Company will have an exhibition of its system as applied on the Albany Belt trains.

THE Brooks Locomotive Works, Dunkirk, N. Y., have recently built a number of 10-wheel engines for the Wisconsin Central Railroad. These have 18 × 24-in. cylinders and 63-in. driving-wheels. The boilers are 54 in. diameter of barrel, with a grate area of $18\frac{1}{2}$ sq. ft., and 1,600 sq. ft. heating surface. They will carry a pressure of 180 lbs. The total weight of these engines is 118,000 lbs., of which 88,800 lbs. are on the driving-wheels. The tenders weigh 75,000 lbs. loaded, and will carry 3,700 galls. of water and eight tons of coal.

A New Double-Screw Ferry-boat.

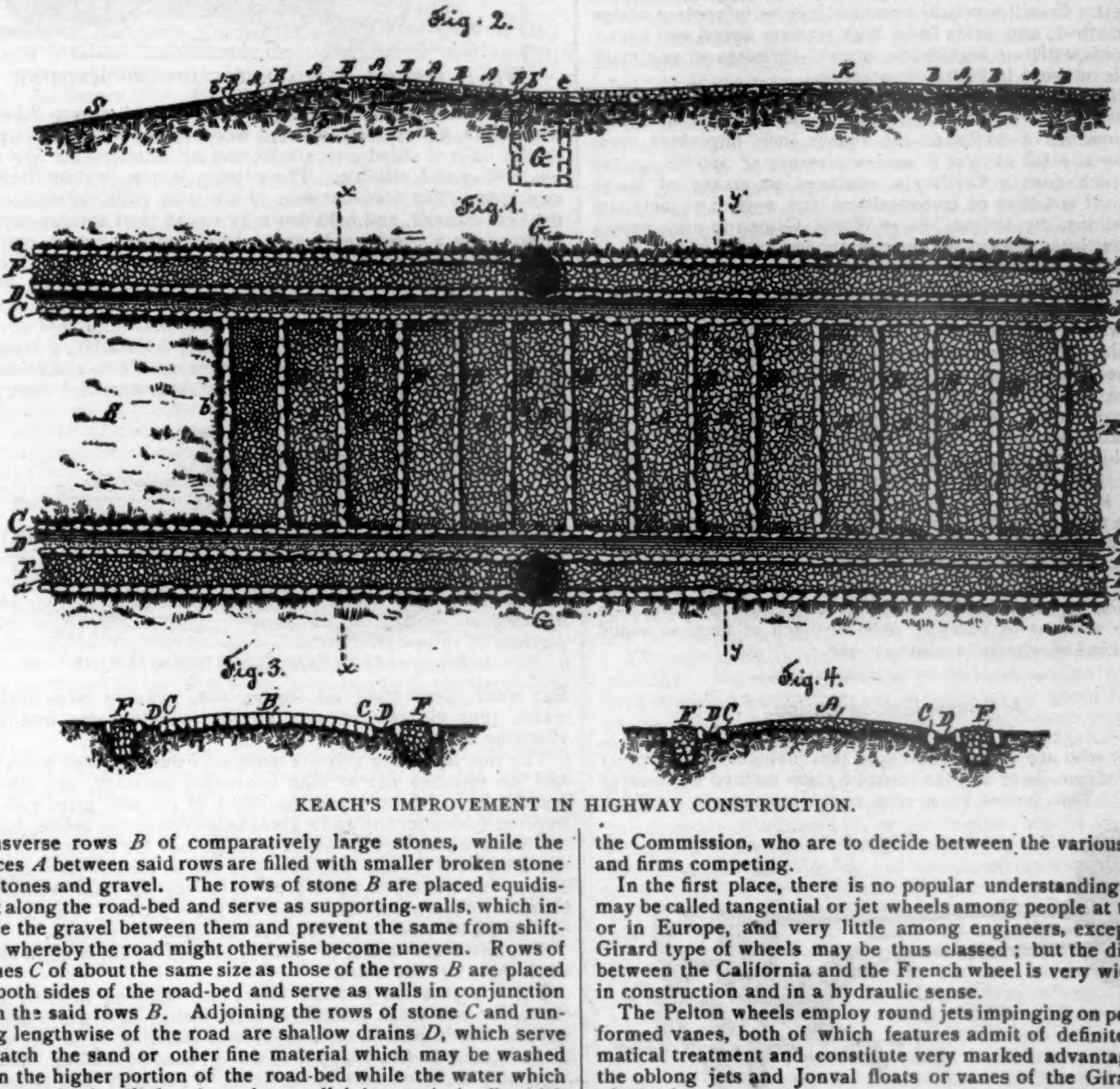
A NEW ferry-boat for the New York, Lake Erie & Western Railroad Company has recently been completed at the yards of Neafie & Levy, in Philadelphia, and will be used in the Company's ferries across the Hudson River, at New York. This boat resembles the *Bergen*, of the Hoboken line, in having a screw propeller at each end, the shaft running the entire length of the boat, and is the second of this class on the river, the *Bergen* being the first. All the other ferry-boats on the Hudson are side-wheel boats. The new ferry-boat is 215 ft. long over all; 188 ft. 3 in. long between stern posts; 45 ft. beam moulded; 62 ft. over guards, and 16 ft. depth of hold. The engines are compound surface-condensing engines, with cylinders 26 and 50 in. diameter by 30 in. stroke. The propellers are 8 ft. 6 in. in diameter. The high-pressure cylinder has a piston valve and the low-pressure a plain slide valve, both driven by a link mo-

tion. The reversing is done by a small steam-engine. There are two boilers, 12 ft. 8 in. in diameter and 11 ft. long. The working pressure will be 100 lbs. The cabins are handsomely fitted up, and the boat is provided with an electric light plant.

A New Plan of Highway Construction.

THE accompanying illustrations represent an improved method of road construction devised and patented by C. E. Keach, of Mapleville, R. I., fig. 1 being a plan of a short section of road-bed; fig. 2 a longitudinal section; fig. 3 a cross-section on the line *x x*, fig. 1; fig. 4 a cross-section on the line *y y*, fig. 1.

It will be seen that the road is divided lengthwise into a series of sections *A A A*, which are separated from each other by



KEACH'S IMPROVEMENT IN HIGHWAY CONSTRUCTION.

transverse rows *B* of comparatively large stones, while the spaces *A* between said rows are filled with smaller broken stone or stones and gravel. The rows of stone *B* are placed equidistant along the road-bed and serve as supporting-walls, which inclose the gravel between them and prevent the same from shifting, whereby the road might otherwise become uneven. Rows of stones *C* of about the same size as those of the rows *B* are placed on both sides of the road-bed and serve as walls in conjunction with the said rows *B*. Adjoining the rows of stone *C* and running lengthwise of the road are shallow drains *D*, which serve to catch the sand or other fine material which may be washed from the higher portion of the road-bed while the water which accompanies it will flow into the parallel deeper drain *F*, which latter is filled with cobble-stones *a*. The dry sand which is washed from the road-bed and settles in the drain *D* can be readily returned to the road-bed or be removed to a suitable place of deposit.

In order to prevent a rush of water from the comparatively level portion *R* of the road at the top of a hill *S* down the road-bed, so as to wash and gully the same, near the top of the incline *S* a shallow depression *c* is made in the road-bed; the water is drained from the same by the side drains *D*, which in this case are inclined, as is indicated by the dotted line *b* in fig. 2, so that the portion of the road-bed included between the lateral rows of stone *b' b'* will form a raised dam or bar, which will serve to prevent the water from rushing down over the inclined road-bed of the hill *S* to wash and gully the same; and in this case also the dam will be constructed of a series of transverse rows of stone *B* with the spaces *A* between the rows filled with fine stone and gravel, and such dams or bars can be made at different parts of the declivity of the hill as may be required to properly guide the water from the road bed.

In the absence of stone of the required size to form the walls *B* and *C* the same can be made of gravel and cement or other suitable material, and in some cases logs of wood can be employed.

Dry-wells *G* may be provided at suitable intervals in the blind drains *F*, whereby the water from the drains will be absorbed by the surrounding earth or gravel.

Jet Water Wheels.

(From *Industry*, San Francisco.)

THE Pelton Water Wheel Company, of San Francisco, will in their tender for the motive-power plant at Niagara Falls labor under several disadvantages that should have consideration by the Commission, who are to decide between the various wheels and firms competing.

In the first place, there is no popular understanding of what may be called tangential or jet wheels among people at the East or in Europe, and very little among engineers, except as the Girard type of wheels may be thus classed; but the difference between the California and the French wheel is very wide, both in construction and in a hydraulic sense.

The Pelton wheels employ round jets impinging on peculiarly formed vanes, both of which features admit of definite mathematical treatment and constitute very marked advantages over the oblong jets and Jonval floats or vanes of the Girard type of wheels.

This branch of the subject has received considerable attention from the engineering faculty of the University of California, and especially from Mr. Ross E. Browne, Hydraulic Engineer, of San Francisco, who assisted at the University experiments conducted in 1883. A bulletin was issued containing the data and results, which constitutes the first literature of the California wheels that found its way into the outer world. Since that time no laboratory tests of these wheels have been made, but there has been a vast amount of observed data which has not only confirmed Mr. Browne's results and computation, but also exceeded in practical use what was laid down or inferred from the laboratory experiments above named.

The wheels are, therefore, in a sense not well known, mainly for the reason that the circumstances which led to their development here in California do not exist elsewhere—working heads of from 100 to 1,000 ft., and even 1,500 ft. Except in the mountainous districts of Europe, where power is but sparingly re-

quired, there is no parallel to these requirements of the Pacific Coast, where every stream is torrential until it reaches the plains.

In the Eastern States, or, as we may say, in the water wheel practice of the world, a fall exceeding 50 ft. is seldom to be dealt with, and among the numerous makers of turbine wheels there has not been much adaptation for higher heads or pressure. This is especially true of the American inward-discharge class of wheels, which have a higher rotative speed than either the Jonval or Fourneyron types, and are consequently less suited for high heads, and where there have been attempts to use them, as in the present plants at Niagara Falls, only a part of the head is uilized, the rest going to waste.

The economical gain by the inward-discharge method of constructing turbine wheels is that the wheel itself, or the running part, which requires finishing, is small in diameter and consequently less expensive to construct. The results attained are much better than theoretical computations or inferences assign to the method, and aside from high rotative speed and consequent inadaptation to high heads, inward-discharge wheels mark a notable advance in hydraulic practice.

At Niagara Falls the makers of turbine wheels meet almost their first experience of California heads, and 140 ft. of fall, with a pressure of 60 lbs. to the square inch, impresses them the same as a fall of 700 ft. and a pressure of 300 lbs. to the square inch does a California engineer, or maker of water wheels. It is a case of transposition, and outside of facts and computations, the Pelton Water Wheel Company may expect at first but little support for their methods.

This is the disadvantage we alluded to at first, and what its weight may be with a scientific commission who are supposed to deal with the problem *a priori* remains to be seen. There are, however, indications of a better understanding of these California water wheels than was at first hoped for. Mr. Ferranti, the Engineer of the power company organized to erect works on the Canadian side at Niagara Falls, and who is one of the most eminent engineers of our time, has detected the peculiar claims and advantages of the tangential water wheels for driving his dynamos, and we are well satisfied that his preference for these wheels will be strengthened by further investigations on his part. . . . . .

It is a strange circumstance, but one not without precedent, that we should, after some centuries of experiment, find in the simple tangential jet water wheel not only the most simple one in form, but that which most nearly conforms to hydraulic laws. During all this time we have been either dividing high falls into sections or utilizing only so much of them as would suit the kind of wheels in common use.

A Convenient Invention.

THOSE who use typewriters—and that includes almost every one nowadays—have felt the want of some method of cleaning the type. This is met by a very neat device made by Ford,

FORD'S TYPEWRITER BRUSH.

Howard & Company, of Chicago, which illustrates well the value of small inventions.

The engraving herewith shows the device so well that hardly any description is needed. It consists only of a revolving brush, carried on a light frame.

The brush is rapidly rotated by means of gears (a special feature of this brush), the proportion of revolutions being three of the brush to one of the hand. This speed not only cleans and dries the type, but really pol shes it. The bristles are three rows deep, ½ in. in length, and of the best quality. The brush operates parallel with the type bars, thus preventing all liability of straining them.

All that need be added is that by simple changes in the frame it can be fitted to any machine, and that on our own Remington it works like a charm.

Some New Wood-Working Machines.

THE object of car builders and railroad shops is usually to secure machinery which will produce the largest quantity of good work in a given time, and to meet this demand the machines shown in the accompanying engravings have been designed.

Fig. 1 shows the special rapid-feed flooring machine, which will work 100 lineal feet of practically perfect flooring per min-

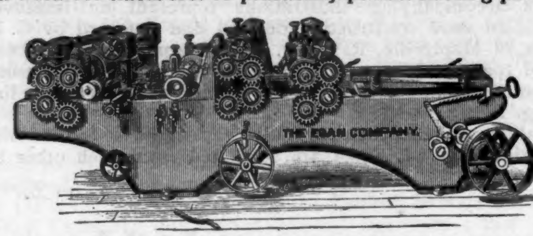


FIG. 1.—SPECIAL RAPID-FEED FLOORING MACHINE.

ute, without trouble, annoyance or breaking down, either in white pine, yellow pine, or hard wood of any kind. It is powerfully built to stand any strain, and all adjustments are simple, strong and reliable. The gearing is new, without links of any kind. The feed consists of six 9-in. rolls, geared up in the best manner, and held down by strong steel springs capable of standing a pressure of seven tons; this pressure can be increased or decreased as desired by a small hand wheel. These feed rolls are provided with improved scrapers, which enable them to run in the gummiest yellow pine without taking any dirt. The pressure-bars are of the best improved character, hugging the knives closely, and are adjustable, giving the machine all the advantages of an inside moulder, and enabling the operator to adjust them to do the smoothest and most per-

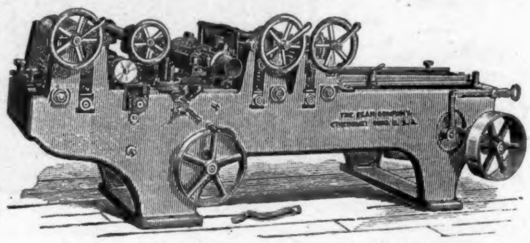


FIG. 2.—FAST-FEED FLOORING MACHINE.

fect work, preventing all tearing out, even in cross-grained wood, thus giving a cut that all mill men look for, free from vibration and tremble.

The side heads are shimers made especially for this machine, and the spindles run in long connected bearings, and are adjustable to any point across the width of the bed, fitted with an improved matcher clip and a great help even to the shimer-head. An independent beader and a pressure-bar for the lower cylinder are placed on this machine, and can be instantly swung out of the way when not wanted or when the operator wishes to sharpen or get at the knives on the lower heads. The beader can be drawn clear back from the cut when not wanted.

Two sizes are made, to work 9 in. and 14 in. wide, and to work three or four sides.

Fig. 2 represents another form, the fast-feed flooring machine, for fast work and quick adjustments, having a capacity of 80 to 100 ft. per minute, capable of standing up to any kind of work, such as flooring, patent siding, beading, ceiling, mouldings, and work of that class, doing it perfectly and reliably. The frame is built upon an improved plan, and will stand any strain that will be put to it.

The cutting cylinders are of the best steel and slotted on all four sides, each side having a knife. The feed consists of six 7-in. rolls, all heavily geared. The system of gearing on this machine is entirely new, all the rolls being driven by internal and external gearing, without expansion links; each upper feed-roll is made to lift parallel, thus giving a full and even pressure across the surface of the board; this is effected by a new and ingenious device for raising and lowering the upper rolls, which can be done instantly to accommodate the thickness of stock. The upper front feed-rolls are held down by a new weighted equalizing bar, allowing ample lifting range to suit unequal stock. The other features are the same as in the rapid-feed machine described above. Two sizes are made, to work 9 in. and 14 in. wide, and to work three or four sides. The former machine is especially recommended for the extra heavy work in large mills and the latter for planing mills, etc., where a first-

class machine is wanted for general work. Both have been very successful in practice.

Both machines have been designed and built by the Egan Company, and further information can be obtained from that Company, whose address is Nos. 194-214 West Front Street, Cincinnati, O.

Notes from Baltimore.

The engine for the new manufacturing enterprise at Curtis Bay, established by the Ryan & McDonald Manufacturing Company, was started up February 10 to test the machinery, and work was begun on the 15th with about 50 mechanics, on contracts taken for locomotives, hoisting engines and small cars.

Arrangements are being made for the construction of an Electric Railroad from a point in South Baltimore to Curtis Bay.

The South Baltimore Car Works, Curtis Bay, have secured an order from the Baltimore & Ohio Railroad for making general repairs to freight cars.

The Baltimore Car Wheel Company are arranging their plant for the manufacture of electrical appliances.

The passenger conductors of the Baltimore & Ohio have had their pay increased, to take effect February 1.

Mr. J. F. Legge, formerly Superintendent of the Western Division, Baltimore & Ohio Railroad, has been appointed General Agent and Superintendent of Wheeling Terminals, with headquarters at Wheeling, W. Va.

OBITUARY.

John Dixon, who died in England, January 28, aged 56 years, was well known as an engineer. He served as apprentice under Robert Stephenson, and was for many years employed in works constructed abroad by English contractors. He built the first experimental railroad in China, from Shanghai to Woosung, which was afterward taken up. He built railroads also in Portugal, Spain and other countries, and harbor works in South Africa.

Hiram Fowler, who died in Westfield, Mass., February 3, aged 60 years, was for many years a civil engineer well known through Connecticut and Massachusetts. He was engaged in a number of works both railroad and city. He was Chief Engineer of the Connecticut Valley Railroad, having charge of its construction from Saybrook to Hartford, and after its completion was made Superintendent, holding that position until it was purchased by the New York, New Haven & Hartford Company.

Joshua L. Pusey, who died in Wilmington, Del., February 8, aged 71 years, was born in Chester County, Pa., but removed to Wilmington at an early age. He learned his trade with the old firm of Betts & Harlan, in Wilmington, and in 1848 founded the firm of Pusey & Jones, in the first place owning only a small machine shop, which gradually grew into the present large shops and shipyard of the Pusey & Jones Company. The present corporation was organized in 1879, Mr. Pusey holding a large interest, and he has been President for four years past, having returned to active business in 1886 after a short period of retirement.

Jacob N. McCullough, who died in Allegheny, Pa., February 8, aged 68 years, was originally a business man in Pittsburgh, but many years ago was induced to take charge of the Cleveland & Pittsburgh Railroad, then almost bankrupt, to save some interest which he owned in the road. He managed the road for several years, bringing the Company up into good condition, and in 1863 was made General Superintendent of the Pittsburgh, Fort Wayne & Chicago Railroad, which was very largely improved under his charge. When the road was leased to the Pennsylvania Company, in 1871, he was made General Manager, and when the Pennsylvania Company was organized, he was chosen First Vice-President, which position he retained until his death, being the chief executive officer of the Pennsylvania System west of Pittsburgh. Mr. McCullough was not an engineer, but was distinguished among railroad men for his ability as a financial manager and in building up and securing traffic.

Robert Forester Mushet, the maker of the celebrated "special tool steel," died February 3, in his 80th year.

In recording his death, the London *Engineer* says: "Mr. Mushet was the youngest son of the late David Mushet, whose labors in the field of iron metallurgy were among the most fruitful in results to British industry in the earlier years of the present century; the most important of them, the discovery of the black band ironstone, having created the Scottish iron trade; while his researches into the manufacture and properties of steel were among the first to throw light upon a then very obscure subject. In the latter field the son became a worthy follower in his father's footsteps, and devoted the greater part of his life to the improvement of the manufacture of crucible steel at his small experimental works at Coleford, in the Forest of Dean, where several notable developments originated, among them being the introduction of China clay into the mixtures for crucibles, whereby they were made more refractory and capable of longer service than before, and the production of specially hard steel by the addition of tungsten and other metallic elements to the iron in the crucible, which resulted in the production of the well-known "special tool steel," which has proved of immense value in the engineer's workshop. These results were, however, overshadowed by his application of spiegeleisen to the Bessemer process, which in the words of the late Mr. Menelaus, in 1876, the President of the Iron & Steel Institute, 'was one of the most elegant as it was one of the most beautiful of processes in metallurgy.' From the narrative published by the inventor himself in 1883, recording the steps that led to this application of manganese to iron when melted in large masses, it will be seen that it was no mere lucky hit, but the result of long continued and careful experiment, and it is sad to think that the discoverer lost the fruits of his labor through the trustees of his patent omitting to pay the fees due in the third year. The value of the discovery was, however, fittingly acknowledged by the award of the Bessemer Gold Medal of the Iron & Steel Institute in 1876, and in a more substantial manner by Sir Henry Bessemer."

Dr. N. August Otto died in Cologne, Germany, January 26, after a brief illness. He started in life, says *Engineering*, as a commercial traveler, for which duties his great mechanical skill was of little avail. Some circumstance turned his attention to gas engines, where his commercial capacity remained valuable. In 1867 he, in conjunction with Eugen Langen, surprised the engineers who had flocked to the Paris Exhibition with a real practical gas engine, an engine of the vertical type, with fly-wheels on the top, not uncanny in appearance, but terribly noisy. The noise had to be borne, and was borne —for the new engine became very popular—for nine years, when the "Otto Silent" was presented. That engine has undergone such manifold improvements that startling innovations and perfections are hardly to be looked for.

The gas engine, in its practical career, has thus quickly attained maturity. Yet the early history of the gas engine has to go back more than 200 years. It is orthodox to quote Huyghens as the first in the field; the series of originators commences, therefore, with one of the best names of physical science. Among the papers of the great physicist is one dated 1640, on a "Novel Motive Force Derived from Gunpowder and Air. Papin took this idea up in 1688, one year after his classical experiment which initiated the steam-engine; but he was not satisfied with the results. Fully a century later, Stree reopened the researches by bringing out and patenting a motor cylinder with explosion by means of a torch. Many others followed, Lebon, Samuel Brown, Wright, Barnett, Newton, Barsanti and Matteucci, Million, and Lenoir, and Hugon, who came very near producing a practical engine. But Langen and Otto's engine of 1867 was so decidedly superior in the economy of gas consumption that the Lenoir and Hugon engines were at once put out of the field. Otto's gas engine embraced the characteristic features of some of its predecessors—it is rarely otherwise in our days—the compression of Barnett, the cycle of Beau de Rochas, and the free piston and other advantages of Barsanti and Matteucci's engine, which was remarkable in many respects, and effected ignition by means of the electric spark. But engineers remain indebted to Dr. Otto for supplying an engine which realized and did what others, who deserve all credit, had been aiming at. We will not here contest the question of priority of invention. It has been fought out many a time; and we believe that no one will grudge Dr. Otto the benefits and comfort which his work and exertions brought him.

He was an honorable man, esteemed by all who knew him, and his invention was not a lucky hit. He was not trained as an engineer, but he made himself one by hard work and study; and his achievements prove his great theoretical knowledge, mechanical dexterity, and fertility of resources.

PERSONALS.

H. R. Thomas has been appointed Railroad Commissioner of South Carolina, succeeding the late M. L. Bonham.

J. S. CAMERON has resigned his position as Chief of Construction of the Union Pacific Railway.

FRANK W. KANE is now Engineer in Charge of Construction of the Pecos Valley Railroad, in Texas.

G. A. O'KEEFE is now Master Mechanic of the Detroit, Lansing & Northern Railroad, with office at Ionia, Mich.

HUNTER MCDONALD is now Chief Engineer of the Western & Atlantic Railroad, succeeding the late EBEN PARDON.

GEORGE D. BROOKE is now Master Mechanic of the St. Paul & Duluth Railroad, succeeding CHARLES F. WARD, resigned.

CHARLES GRAHAM, Jr., is now Master Mechanic of the Bloomsburg Division of the Delaware, Lackawanna & Western Railroad.

ELWOOD S. SCHUTZ has been appointed Master Car-Builder of the Georgia Railroad, succeeding T. M. PREVAL, who has been assigned to other duty.

ARTHUR P. HERBERT is now engineer and Superintendent of the Colima Division of the Mexican Central Railroad; his headquarters are at Colima, Mexico.

DAVID BROWN is now Master Mechanic of the Delaware, Lackawanna & Western Railroad, having charge of the motive power and machinery of the main line.

S. H. HARRINGTON has resigned his position as Mechanical Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railroad, and will devote his time to introducing his signal system and some other inventions.

FREDERICK P. DEWEY, late of the National Museum, has established in Washington a laboratory for the analysis of ores and other substances, the investigation of chemical and metallurgical processes and other similar work.

VIRGIL G. BOGUE, for many years Chief Engineer of the Union Pacific, has resigned, but will continue to have charge of the construction of the company's new line in Oregon. Mr. Bogue's successor is E. C. SMEED, late Assistant Engineer.

F. W. D. HOLBROOK, C.E., recently Manager of the Seattle, Lake Shore & Eastern Railroad, has accepted the position of Secretary of the new Board of Public Works, at Seattle, Wash. Mr. Holbrook is an engineer of experience and standing.

CHARLES GRAHAM has resigned his position as General Master Mechanic of the Delaware, Lackawanna & Western Railroad. He has been connected with the road for many years in various capacities, and now retires on account of ill health.

JOHN D. CAMPBELL is now Assistant Superintendent of Motive Power of the New York Central & Hudson River Railroad. He was formerly on the Central Railroad of New Jersey, and more recently on the Manhattan Elevated Railroad in New York.

PHILIP WALLIS is now Master Mechanic of the Eastern Division of the Norfolk & Western Railroad, with office at Roanoke, Va. He was recently Division Master Mechanic in charge of the shops at Creston, Ia., on the Chicago, Burlington & Quincy Railroad.

HARVEY MIDDLETON has resigned his position as Superintendent of Motive Power of the Union Pacific, and is succeeded by JOSEPH MCCONNELL. Mr. Middleton has shown much ability and has many friends, and his retirement is due entirely to the change in administration of the company.

CAPTAIN EDMUND BERKELEY has been appointed Superintendent of the Richmond & Danville Railroad. C. P. HAMMOND succeeds Captain Berkeley as Superintendent of the Atlanta & Charlotte Division. W. B. RYDER, formerly on the Chesapeake & Ohio, succeeds Mr. Hammond as Superintendent of the Georgia Pacific Railroad.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—The principal business transacted at the annual meeting in January was the discussion of the reports of the Committee on Amendment of the Constitution, and a number of amendments were ordered submitted to letter ballot. The different standing committees reported progress.

The report of the Board of Directors showed a total of 7 honorary members; 3 corresponding members; 1,080 active members; 61 associate members, and 215 junior members. There are also 56 fellows of the Society. Additions during the past year were 150.

The Norman medal was awarded to John R. Freeman for his paper on Experiments Relating to the Hydraulics of Fire Streams. The Rowland prize was awarded to the paper on the Sibley Bridge, by O. Chanute, J. F. Wallis and W. H. Breithaupt.

AT the regular monthly meeting, February 4, the tellers announced the following elections: *Members:* Patrick J. Flynn, Tulare, Cal.; Conway B. Hunt, Washington, D. C.; Norton Taylor, Tacoma, Wash.

Junior: Maurice A. Viele, New York.

A paper on the Use of Asphalt in Building Sea Walls, by W. C. Ambrose, was read. It referred especially to the construction of a wall on the Southern Pacific in Southern California, where the asphalt used was from California bituminous rock. This was discussed by members present.

A paper on the Howe Strut Problem, by N. J. Conover, of too mathematical a nature to be read, was ordered printed.

Canadian Society of Civil Engineers.—The annual meeting was held in Montreal, January 16. The Secretary reported total expenditures of $3,591, with a balance of $2,730 on hand. The building fund now amounts to $2.840; a number of donations to the library were received. There are now 633 members in all.

The Gzowski medal was awarded to H. P. Vauteler for his paper on Bridge Construction.

The following officers were elected: President, Sir Casimir Gzowski; Vice-Presidents, J. Kennedy, E. P. Hannaford and F. J. Lynch; Treasurer, H. Wallis; Secretary, H. T. Bovey; Librarian, F. Chadwick.

Engineering Association of the South.—The regular meeting was held in Nashville, Tenn., February 12. A paper entitled Weather Forecasts and How to Make Them was read by J. B. Marbury, United States Signal Officer at Nashville. It was followed by a discussion by members present.

Boston Society of Civil Engineers.—At the regular meeting, January 21, a Committee was appointed to nominate officers for the ensuing year.

Papers were read on Survey Outfits by Frank P. Johnson, and on the Improvement of the Upper Missouri, by Lawrence Bradford.

New England Water-Works Association.—An adjourned meeting was held in Boston, February 11. The paper presented by Mr. Davis at the preceding meeting, describing the moving of 700 ft. of pipe, was discussed, and some further information drawn out.

Mr. George F. Chase read a paper on the Care of Water Mains, with special reference to the effect of the condition of the pipes on the quality of the water. He held that, to keep water supply in satisfactory condition, as much depends on the care of the mains as on that of the reservoir.

Mr. Gowing presented a paper on the Best Means of Laying Water Pipe Across a River. This called out considerable discussion as to whether it was best to lay pipe under a river or on a bridge, and a number of members presented their experience.

Superintendent Forbes read a paper on Driven Wells, having special reference to the best material and form of construction, and to the character of the water obtained by such wells in Brookline, Mass. This paper was discussed by a number of members present.

Engineers' Club of Philadelphia.—At the regular meeting, January 17, the Secretary presented, for Mr. George R. Henderson, an illustrated paper upon Locomotive Driving Springs. He had occasion some years ago to examine quite thoroughly the laws governing the deflection of locomotive springs, and found the formula usually given in books to be incorrect, because the shape of the spring is not given due consideration. He constructed a new formula, which he has proved by actual tests in a number of cases.

Mr. Carl Hering read a paper on a Portable Photometer for Measuring Street Lights and Illumination in General. After enumerating the difficulties attending such out-door measurements, he described the portable photometer devised by him, which had given very satisfactory results. The method adopted differed from the usual one in that the standard of light and the unknown light were both on the same side of the screen, and were

balanced by an auxiliary portable light in the photometer at a fixed distance from the screen. The photometer is first calibrated by balancing this auxiliary light against the standard ; this is done indoors. The photometer is then ready for use out of doors, the unknown light being balanced against the auxiliary by moving the whole photometer to or from the light. The adjustments are made so as to reduce the calculations to the simplest possible. The photometer consists of a light wooden tube open at both ends and containing the screen and auxiliary light, together with the switch and tape for measuring the distance. The auxiliary light was a small electric light supplied by a portable accumulator carried by the operator. This photometer could also be used to measure illumination in general, such as daylight, sunlight, moonlight, or the illumination on a table, desk, etc., for which measurements a stationary photometer cannot be used.

THE officers elected for 1891 are : President, Wilfred Lewis ; Vice-President, S. M. Prevost ; Secretary and Treasurer, Howard Murphy ; Directors, Rudolph Hering, Percival Roberts, Jr., F. H. Lewis, R. J. Salom and George S. Webster.

Ohio Institute of Mining Engineers.—The eleventh annual meeting was held in Columbus, O., beginning January 22. The annual address was delivered by the President, Mr. Anthony Howells, of Massillon. The meeting continued two days and a number of papers of interest were read, including one by Professor Orton on Corporations and Natural Gas Supplies ; by J. A. Ede on the Minerals of Virginia ; by N. W. Lord on Blast Furnace Tar and Ammonia ; by Andrew Roy on the Lower Coal Measures of the Ohio and Big Sandy, and a number of others.

The meeting was varied by visits to the manufacturing establishments in Columbus and vicinity. Much attention was paid to the works of the Lechner Electric Company, where the specialty is the application of the electric motor to mining machinery.

The following officers were elected : President, Anthony Howells, Massillon ; Secretary and Treasurer, R. M. Hazeltine, Columbus ; Executive Committee, N. W. Lord, F. W. Sperr and Andrew Roy.

Engineers' Club of Cincinnati.—At the regular meeting, January 15, Louis Zepernich and John W. Cowper were elected members. On report of the special Committee it was decided that the question of the Club becoming a member of the Association of Engineering Societies be deferred for the present.

Mr. Edwin A. Hill, Real Estate Agent of the Cleveland, Cincinnati, Chicago & St. Louis Railroad, read a paper on Office Records, which comprised a very thorough and comprehensive description of the manner of filing the correspondence, deeds, leases, agreements, etc., and conducting the accounts and correspondence of one of the most important and busy departments of the various railroads comprising the Big Four system.

Engineers' Club of Minneapolis.—At the annual meeting, January 15, the following officers were elected : President, Professor W. A. Pike ; Vice-President, T, P. A. Howe ; Secretary and Treasurer, F. W. Capelleu ; Librarian, A. B. Coe.

Arrangements were completed for holding joint meetings with the St. Paul Club in addition to the regular meetings of the Club in Minneapolis.

Technical Society of the Pacific Coast.—At the annual meeting in December the following officers were elected : President, John Richards ; Vice-President, Luther Wagoner ; Treasurer, George F. Schild ; Secretary, Otto von Geldern ; Directors, Hermann Kower, Ross E. Browne, C. E. Grunsky, James W. Reid, Alpheus Bull.

AT the regular meeting, January 2, R. B. Elder read a paper on Electrical Accumulators, giving the history and application of storage batteries up to the present time.

Mr. A. T. Herrmann submitted a draft of an act to regulate land surveying. This called out considerable discussion, and it was generally admitted that legislation was very much needed. The subject was finally referred to a special committee with power to revise the proposed bill and submit it to the Legislature.

Engineers' Society of Western Pennsylvania.—The annual meeting was held in Pittsburgh, January 20, when the Secretary reported a total of 370 members. The standing committees presented their reports, and the retiring President, Mr. W. L. Scaife, made his annual address.

The following officers were elected for the ensuing year : President, Colonel T. P. Roberts ; Vice-President, A. E. Hunt ; Secretary, J. H. Harlow ; Treasurer, A. E. Frost.

Mr. Charles F. Scott read a paper on Electrical Plant for Mining Coal, the discussion of which was postponed until the next meeting.

Southern Society of Civil Engineers.—A meeting was held at Jacksonville, Fla., January 20. The President, Mr. L. J. Barbot, of Charleston, S. C., delivered an address, which was ordered printed for the use of members. It was resolved that the present officers should hold over for another year.

A number of new members were elected. It was decided to hold quarterly meetings during the current year, the next one to be at Savannah, April 20, and the third at Charleston, July 20. The place and date of the October meeting will be announced hereafter.

New England Railroad Club.—The regular monthly meeting was held in Boston, February 11. The subject for discussion was the Painting of Cars, which was opened by Mr. Charles Richardson, who spoke at length, saying that interior decoration is an important factor in railroad economy, for no car is complete or acceptable to the traveling public unless good taste has been used in making it attractive. This accomplished, distances seem shorter and trips pleasanter to the passenger and better patronage for the road is secured. The exterior painting, decorating and varnishing of passenger and freight cars are also real problems to be solved. It is difficult to slight this work, except at the expense of durability. The quality of material used is more important than the price. Many of the articles, such as oil and varnish, should be bought in large quantities, allowing them time to become well settled before using. All material should be pure and finely ground. The mixing or preparing of paint should be in the hands of one person, who should weigh and measure each article rather than guess at quantities. Many coatings are not advisable ; light coatings dry quicker, harder, and are less liable to crack, scale or fade. Always use pure linseed-oil.

A number of Master Painters from different roads were present and a long discussion followed these remarks, the speakers being Messrs. Brown and Lange of the Old Colony ; Hibbard and Jewett, of the Boston & Albany ; Nelson and Walton, of the New York, Providence & Boston ; Worrall, of the Boston & Maine and others.

Western Railway Club.—At the regular meeting, in Chicago, February 17, the first subject for discussion was Vertical Plane Couplers, which was continued over from the January meeting.

This was followed by a discussion upon the paper on Counterbalancing Locomotives, which was read at the January meeting.

The third subject was Car Lighting, on which a paper was presented by Mr. George M. Gibbs, Mechanical Engineer of the Chicago, Milwaukee & St. Paul Railroad.

Central Railway Club.—At the quarterly meeting, in Buffalo, January 28, the subjects discussed were the Amount of Fastening Necessary on Center Plates and the Amount of Breakage of a M. C. B. Coupler which would Cause the Rejection of a Car.

The following officers were elected for the ensuing year : President, Eugene Chamberlain ; Vice-President, F. B. Griffith ; Secretary, John McBeth.

American Society of Mechanical Engineers.—The 23d meeting, which will be the spring meeting of 1891, will be held in Providence, R. I., about the second week in June. The exact time and the arrangements for the meeting will be announced later.

Papers to be read at this meeting must be in the Secretary's hands by May 1 at the latest.

NOTES AND NEWS.

The Sault Ste. Marie Canal.—General Poe has been advised that the contract to build the new lock in the Sault Canal has been awarded to Hughes Brothers & Bangs, of Syracuse, N. Y., their bid being $1,268,500. Work will be begun on the contract as soon as it is possible to get machinery and material on the ground. The lock is to be 800 ft. long and 100 ft. wide.

At the mean of low waters there will be a depth of 21 ft. in the lock. At the present stage of water there would be 22 ft. 4 in. In the lock there will be over 80,000 cubic yards of masonry. Over 3,500,000 feet of lumber will be required in its construction. The gates alone will weigh over 1,200 tons. It is hoped that the lock will be completed in five years.—*Marine Review.*

Photographing Bad Roads.—The League of American Wheelmen, which is naturally much interested in the improvement of roads, proposes to use for that purpose a series of object lessons, or "awful examples," and has, therefore, offered three prizes for the best collections of photographs showing the actual condition of public roads, by which are meant the ordinary highways and not city streets. The prizes are $50, $30 and $20, and the collection must include not less than three photographs. These should show the actual condition of roads at their worst, with the inevitable results—breakdowns, wagons stuck in the mud, etc. As a contrast, photographs of good smooth roads will also be acceptable. Further information can be obtained from Mr. Charles L. Burdett, of Hartford, Conn., or Mr. Isaac B. Potter, No. 278 Potter Building, New York.

Detecting Flaws in Iron and Steel.—Captain de Place, of Paris, has invented an instrument for detecting flaws in metal castings and forgings, which is called the sciséophone. According to the London *Times*, the apparatus consists of a small pneumatic tapper worked by the hand, and with which the piece of steel or iron to be tested is tapped all over. Connected with the tapper is a telephone with a microphone interposed in the circuit. Two operators are required, one to apply the tapper and the other to listen through the telophone to the sounds produced. These operators are in separate apartments, so that the direct sounds of the taps may not disturb the listener, whose province it is to detect flaws. The two, however, are in electrical communication, so that the instant the listener hears a false sound he can signal to his colleague to mark the metal at the point of the last tap. In practice the listener sits with the telephone to his ear, and so long as the taps are normal he does nothing. Directly a false sound—which is very distinct from the normal sound—is heard, he at once signals for the spot to be marked. By this means he is able not only to detect a flaw, but to localize it. Under the auspices of the South-eastern Railway Company, a demonstration of the sciséophone was given recently by Captain de Place in the presence of several members of the Ordnance Committee and other Government officials. Mr. Stirling, the company's Locomotive Superintendent, had previously had several samples of steel, wrought iron and cast iron prepared with hidden flaws known only to himself. The first sample tested by Captain de Place he pronounced to be bad metal throughout, which Mr. Stirling stated he knew it to be. Other samples were tested, and the flaws localized by means of the apparatus. On some of the bars of wrought and cast iron being broken, the internal flaws—the localities of which were known to Mr. Stirling by his private mark—were found to have been correctly localized by Captain de Place. On the other hand, some bars were broken at points where the apparatus indicated a flaw, but where the metal proved to be perfectly sound; so that the apparatus is not yet quite trustworthy.

A Twin Screw River Boat.—The accompanying illustration, from *Le Yacht*, shows a light boat for service on the Mekong River, in Cochin-China, built by M. Dubigeon, at Nantes, France. She is 164 ft. long, 23 ft. wide and 5 ft. 7 in. deep; she draws only 27½ in. of water when fully loaded. The two engines are triple-expansion, made very light, and steam is supplied by two locomotive boilers of steel, built to carry 145 lbs. working pressure; the fuel will be wood. The twin screws work in recesses formed in the after end of the boat, as shown by the dotted lines in fig. 1; fig. 2 is a cross-section showing the arrangement and the form of these recesses.

The boat has two decks, but is provided with very little cabin

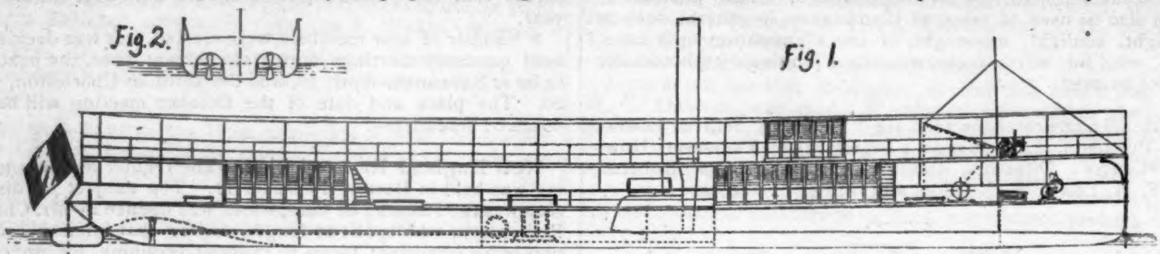


Fig. 2. Fig. 1.

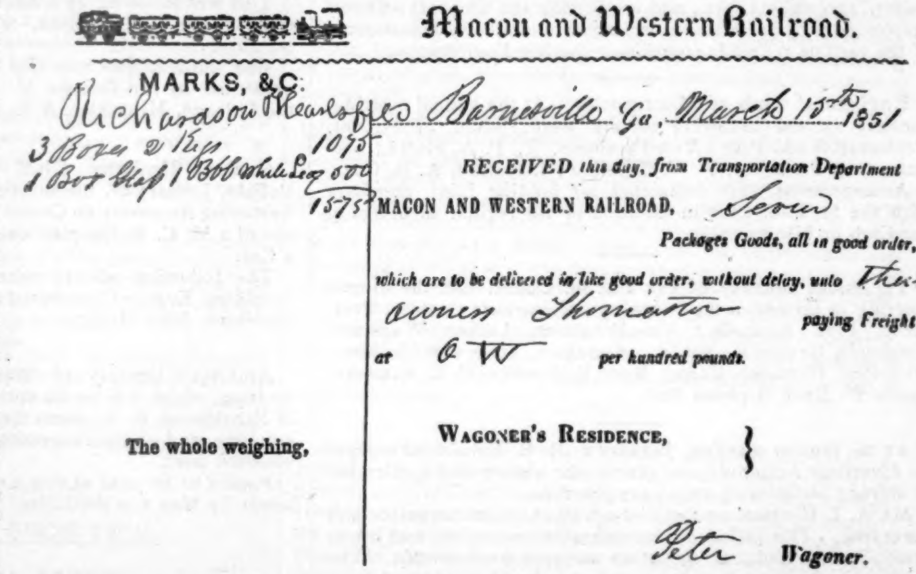
accommodation, the open decks being preferable in the very hot climate where she is to work.

The Great Pendulum in the Eiffel Tower.—M. Mascart has recently placed in the Eiffel Tower a pendulum which is certainly the largest ever put up. It consists of a bronze wire 115 meters (377.20 ft.) long, attached to the center of the second platform of the tower and reaching to a point 2 meters (6.56 ft.) from the ground. This wire supports a steel sphere weighing 96 kilogrammes (211.58 lbs.).

It may be noted here that a pendulum was once suspended under the dome of the Pantheon by M. Foucault, and that there has been recently some talk of replacing it there.

There has also been, for some months past, in the tower of St. Jacques, a pendulum extending from the top nearly to the bottom, the weight of which describes its oscillations in the hall on the second story.—*Revue Scientifique, Paris.*

An Old Time Bill of Lading.—The accompanying is a reproduction, on a reduced scale, of an old-time document, sent to us by Mr. J. A. Droege, Master of Transportation of the East Tennessee, Virginia & Georgia Railroad, who writes: "The enclosed is a relic of interest, a bill of lading dated March 15, 1851—about 39 years ago—of the Macon & Western Railroad; this is the old name for the Central of Georgia. Barnesville to Thomaston is a distance of 16 miles; my presumption is that the figures in the upper left-hand corner represent weights



Macon and Western Railroad.

MARKS, &C.

Richardson & Kearloffes Barnesville Ga., March 15th 1851

3 Boxes 2 Kegs 1075

1 Box Glass 1 Bbl White Lead 500

1575

RECEIVED this day, from Transportation Department

MACON AND WESTERN RAILROAD, Seven

Packages Goods, all in good order,

which are to be delivered in like good order, without delay, unto their

owners Thomaston paying Freight

at 6 W per hundred pounds.

The whole weighing,

WAGONER'S RESIDENCE, }

Peter Wagoner.

of various articles, as they would be rather high freight charges, even in that day."

The goods, whatever they were, seem to have completed their journey from Barnesville by team, as the wagoner "Peter"—now doubtless gone, with his team—has receipted for them. The document bears marks of age, but is in better shape than might be expected.

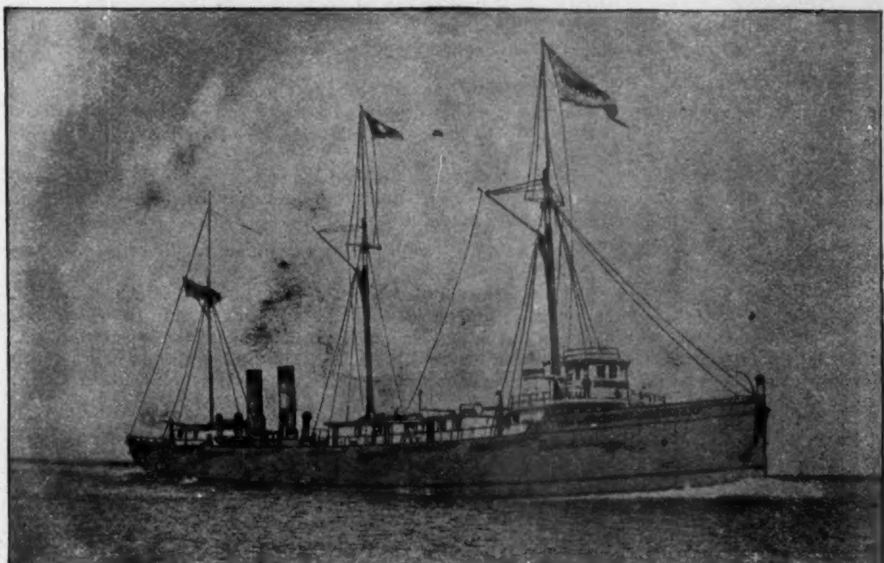
Big Guns.—Mr. J. H. Longridge, the eminent English mechanical engineer, has written a pamphlet in which he says that with a pressure of 30 tons, and the comparatively short gun he recommends for naval use, the high velocity of 3,000 ft. a second could be easily attained, and he concludes his *brochure* by utterly condemning long guns, and stating his "conviction . . . that guns of a very large caliber are a further mistake," and "that a 9-in. or 10-in. high-pressure gun would be sufficient for any effect that is required against the heaviest armor afloat."

Population of Japan.—Official returns show that the population of Japan on December 31, 1889, was 40,072,020—20,246,336 males and 19,825,684 females—who occupied 7,840,872 houses. Subdividing the population into classes, there were 3,825 *Kwazoku* (nobles), 1,993,637 *Shizoku* (middle class), and 38,074,558 *Heimin* (lower class). As against the previous year there is an increase of 464,786 in the population, and of 38,046 in the number of houses. Of the total population 14,890,238 were married and 25,181,782 (12,801,217 males and 12,380,565 females) unmarried.

A Lake Carrier and Her Work.—The accompanying illustration, for which we are indebted to the Cleveland *Marine Review*, shows the steamer *Harlem*, belonging to the Western Transit Company, and employed in that company's line between Buffalo and Chicago. This boat left Buffalo for Chicago on her first trip, April 8, 1890, and between that time and the close of the season of navigation made 27 round trips, handling in all 102,500 tons of freight, or an average of about 3,800 tons.

The *Harlem* cost $250,000; she was built by the Detroit Dry Dock Company in Detroit.

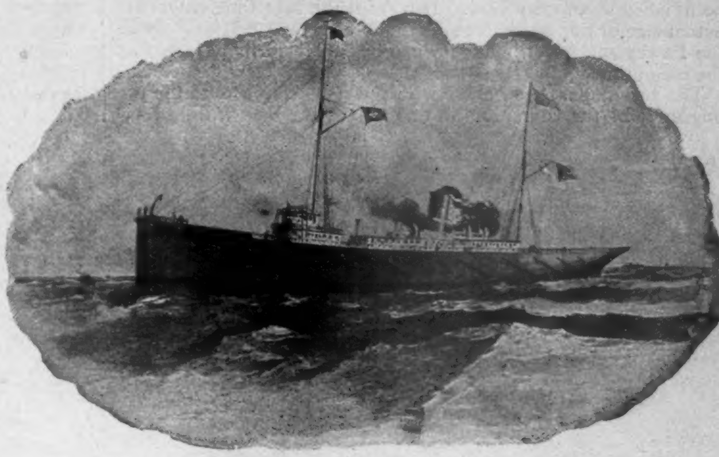
The smaller illustration, also from the *Marine Review*, shows the steamer *Owego*, which is not only a large carrier, but has the reputation of being the fastest large boat on the lakes.



WESTERN LINER "HARLEM."

Color Blindness.—Extensive tests have recently been undertaken in Russia as to color-blindness among the various railway servants. The result was that of 12,542 switchmen, 68 were color-blind; of 4,620 station-masters, 17 were color-blind; of 6,321 machinists, 21 were color-blind, and of 18,000 watchmen on the railways, 140 were color-blind. The various color-blind officials have now been either transferred to occupations where this defect is of no importance, or dismissed.

The Lansdowne Bridge.—A description of the bridge thus named, which is one of the great bridges recently completed in India, is given in a paper recently read before the Institution of Civil Engineers in London by Mr. F. E. Robertson. At Sukkur, where the Northwestern State Railway has been carried across the Indus, the river passes through an isolated ridge of nummulitic limestone, and is divided into two channels. The Sukkur Pass is bridged by three spans of 278 ft., 238 ft. and 94½ ft. respectively, while the Rori Channel is crossed in a single span of 820 ft. The steel superstructure of the last-named span was designed by Sir A. M. Rendel, and consists of a pair of cantilevers, each having a projection of 310 ft., carrying between them a central girder 200 ft. in length. The paper was principally a description of the methods employed in the erection of this span. Each cantilever has a vertical height of 170 ft. above the abutment, and at this point the principal members consist of a vertical pillar and an inclined



UNION LINER "OWEGO."

strut or jib, united at the top by a horizontal tie, and tied back by an inclined land-tie or backstay anchored into the rock. When the anchorage had been bedded, the inclined guy and the vertical pillar were erected by means of temporary staging, and were permanently connected at the top. The inclined strut, which is 230 ft. in length, was then built up from the abutment, being laid in its inclined position on staging at the lower end, and further supported, as it progressed, by temporary wire ropes from the vertical pillar. For the erection of the permanent horizontal tie between the tops of the pillar and the strut, a temporary wire rope suspension bridge was thrown across the space of 123 ft. between their summits. This bridge carried a gantry, on which ran the travelers employed in erecting the steelwork of the horizontal tie. The cantilevers on each side of the river having thus been pushed forward with an over-reach of 123 ft., a system of running overhead rope gear was fitted up, spanning the invervening gap, and serving for the erection of the remaining members of each cantilever piece by piece. The ropes were worked from the summit of each cantilever by winches, which were driven by a steam-engine on and by means of a running rope. When the cantilevers had thus been carried out to their full length, the central girder was erected upon a temporary inverted bowstring, which was slung across the opening with the aid of the overhead gear.

Structural Iron.—The increase in the use of structural iron in the Northwest is one of the most interesting points in the marvelous development of the section, and is by no means confined to the two or three cities therein which lay claim to metropolitan distinction. In nearly all public buildings and in private enterprises of the more permanent and substantial character, whether they are in towns of a hundred thousand or two thousand inhabitants, more or less architectural iron work is used, and experienced builders say the proportion consumed is quite as heavy in the Northwest according to population as it is in the East. When it is considered that the cities and towns of the Northwest have all been built in a hurry and supposedly with less regard for the element of permanence than the necessity for expedition, the true importance of the fact is plain. As an industry the manufacture of architectural iron ought to

grow very rapidly and keep pace fully with the development of the iron resources of the country.—*Northwestern Mechanic.*

The Topographical Survey of Connecticut.—For two years past this survey has been in progress under charge of a Commission consisting of Professor William H. Brewer, of New Haven; James H. Chapin, of Meriden, and John W. Bacon, of Danbury. The work is carried on in co-operation with the United States Geological Survey, and will probably be finished in another year. It will for the first time show the actual size of the State, if the dispute with Rhode Island about the Pawcatuck River boundary can be satisfactorily adjusted in the mean time.

The survey has been made with special reference to the topography of the State, and in this regard the map will be very accurate. Owing to the fact that several of the towns have neglected to mark out their boundary lines, from local disputation or other cause, the subdivisions of the State cannot be marked with the exactitude that was desired; but for this those towns themselves will be the principal sufferers.

The map, which is to be published next year, will show all the contours and delineations of the surface of the land, denote every lake, river, railroad, and highway, and will also show the drainage of each stream that might possibly be used for local drain or sewer work. The map is to be published in 26 sheets, each about 12 × 17 in. A section will represent 200 square miles of surface, averaging about six towns. The scale to be used is 1 to 62,500.

Separate maps will show the divisions of cleared, tillable, and forest lands. A notable fact that has been brought out by this survey is that in the valley through which the Northampton Railroad runs there are no tillable lands above an altitude of 400 ft. between New Haven and Simsbury, a distance of 42 miles, while about eight miles to the west some of the very best farms are 800 ft. or more above the sea level.

The Washington Heights Viaduct.—An engineering work of considerable importance is the viaduct on which work is now in progress, and which is to extend from St. Nicholas Place in New York City to Seventh Avenue and 155th Street, close to the southern end of the Macomb's Dam Bridge. The viaduct is 1,600 ft. long, and the difference in height between the two ends is about 80 ft., requiring a uniform grade of 5 ft. in 100. The abutment at St. Nicholas Place, where there is a high rocky bluff rising from the low bank of the Harlem River, will be about 60 ft. in height, the foundation being blasted out from the rocks at the foot of the bluff. The viaduct will be carried from that point to Eighth Avenue on spans of 44 ft., each supported by iron towers rising on masonry foundation. At Eighth Avenue the viaduct will be 48 ft. above the street and some 27 ft. above the elevated railroad, which it crosses at that point. For the remainder of the distance to Seventh Avenue the spans will be 43 ft. each.

The full width of the viaduct will be 60 ft., of which 40 ft. will be a road-bed for vehicles, the remainder being taken up by a 10-ft. sidewalk on each side. Over the elevated station at Eighth Avenue there will be a plaza or platform 80 × 100 ft., from which stairs will descend to the station. The roadway will be made of steel buckle-plates, over which will be placed a layer of concrete, upon which will rest a granite block pavement of the kind ordinarily used in the streets. The sidewalks will be of asphalt. The viaduct is to be completed about a year from the present time. The work now in progress is the construction of the stone foundations for the iron piers.

In connection with this viaduct a new bridge is to be built over the Harlem River, which will be known as the Webster Bridge, and will take the place of the old Macomb's Dam Bridge. The plans for this had been prepared, but some changes have been proposed, and it is not impossible that others will be required, owing to legislation on the Harlem improvement, which will be urged at Albany this winter.

A Japanese Canal.—A canal has recently been completed in Japan to connect Lake Biwa with the Kamagawa River and the city of Kioto. This canal is 6.88 miles long altogether, and has on its course some important works. The accompanying illustrations are views on the line, taken for *La Nature.*

The canal has to pass through several ranges of mountains, and this is effected by means of three tunnels, the length of which are 8,040 ft., 411 ft. and 2,802 ft. respectively. These tunnels are of the section shown in fig. 2, and have a breadth of 16 ft. and a height of 14 ft. They are lined throughout with masonry. Fig. 2 shows the entrance to No. 1 tunnel, which is 8,040 ft. long and is the second longest in Japan. At a distance of about 5¼ miles from Lake Biwa the canal is divided into two portions, one joining the River Kamagawa, and the other leading northward to Kogawa, the northern extremity of the city of Kioto. The second portion of the canal, after passing through a tunnel 450 ft. long, crosses the Valley of the Imperial Tombs by a handsome aqueduct, which is shown in fig. 3. This aqueduct is 300 ft. long, and consists of 14 arches of masonry.

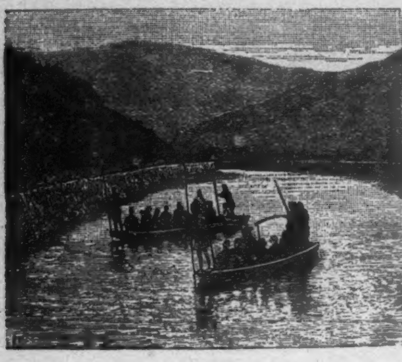


Fig. 1.—Entrance to the Canal from Lake Biwa.

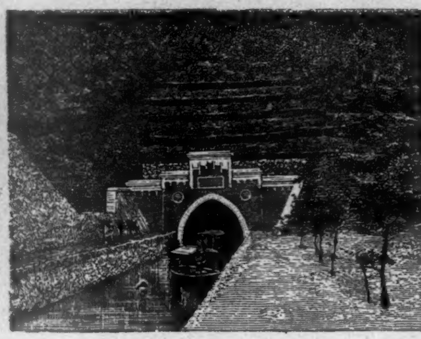


Fig. 2.—Entrance to No. 1 Tunnel.

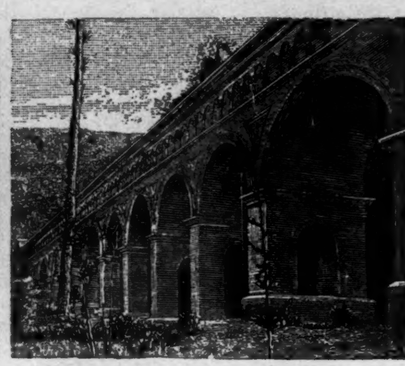
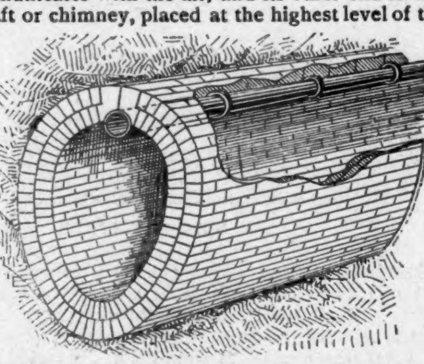


Fig. 3.—Aqueduct Carrying Canal across a Valley.

Fig. 1 shows the entrance to the canal at the extremity of Lake Biwa. This entrance was formed by reclaiming about 1,000 ft. of the lake, and forming a breakwater to protect it and ensure still water.

The canal serves a double purpose, furnishing a line of navigation, and bringing down the water from Lake Biwa for use in irrigating the lands about Kioto.

Ventilating Sewers.—The accompanying illustration shows a method of ventilating a sewer devised by Messrs. A. Ford and E. Wright, and recently tested at Portsmouth, England. It consists in placing a special ventilating pipe in the upper part of the sewer with openings at intervals; at the lower end this pipe communicates with the air, and its other end is in a ventilating shaft or chimney, placed at the highest level of the sewer.



A current of air is induced by forcing a small stream of water through the pipe.

In the sewer where it was tried, which is 47 in. in diameter and about 10 ft. below the surface, the ventilating-pipe is of steel, 5½ in. in diameter and made in lengths of 30 in., with an opening close to each joint. The pipe was fixed to the brick of the sewer by staples driven in.

In a length of 300 ft. selected for the test a water current consuming 3½ cub. ft. per hour was found to cause a current through the ventilator varying from 330 to 380 ft. per minute, according to the amount of water in the sewer, the height of the latter varying from 14 in. to 29½ in. The discharge from the ventilator was from 2,100 to 2,500 cub. ft. per hour, which, allowing for the varying level, was equivalent to a complete renewal of the air in an hour.